

AR201-13756B

**The Flavor and Fragrance High Production Volume  
Consortia**

**The Terpene Consortium**

**Robust Summaries for Monoterpene Hydrocarbons**

<i>d</i> -Limonene	CAS No. 5989-27-5
<i>dl</i> -Limonene	CAS No. 138-86-3
Terpinolene	CAS No. 586-62-9
Myrcene	CAS No. 123-35-3
Dihydromyrcene	CAS No. 2436-90-0
Hydrocarbons, terpene processing by-products	CAS No. 68956-56-9
Orange peel oil, sweet ( <i>Citrus sinensis</i> (L.) Osbeck)	CAS No. 8008-57-9
Terpenes & terpenoids, sweet orange oil	CAS No. 68647-72-3
Terpenes & terpenoids, turpentine oil, limonene fraction	CAS No. 65996-99-8
Terpenes & terpenoids, limonene fraction	CAS No. 65996-98-7
Terpenes & terpenoids, turpentine oil, limonene fraction, distillation residue	CAS No. 68334-40-7
Terpenes & terpenoids, turpentine-oil residue	CAS No. 68938-00-1

**FFHPVC Terpene Consortium Registration Number**

Submitted to the EPA under the HPV Challenge Program by:  
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# The Flavor and Fragrance High Production Volume Consortia

## Robust Summaries for Monoterpene Hydrocarbons

The evaluation of the quality of the following data uses a systematic approach described by Klimisch [Klimisch *et al.*, 1996]. Based on criteria relating to international testing standards for categorizing data reliability, four reliability categories have been established. The following categories are:

- Reliability code 1.      Reliable without restrictions
- Reliability code 2.      Reliable with restrictions
- Reliability code 3.      Not reliable
- Reliability code 4.      Not assignable

## 1 Chemical and Physical Properties

### 1.1 Melting Point

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Measured
<b>Melting Point</b>	-74.35 °C
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

<b>Substance Name</b>	<i>d</i> -Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Measured
<b>Melting Point</b>	-97 °C
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, Florida.

## 1.2 Boiling Point

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	176 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Fragrance Materials Association (FMA) Boiling point.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	178.6 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.

**Remarks for Data Reliability** Code 2. Basic data given: comparable to guidelines/standards.

**References** CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	175.5-176 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

<b>Substance Name</b>	<i>d</i> /-Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	175.5-176.5 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

<b>Substance Name</b>	<i>d</i> /-Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	178.6 °C
<b>Pressure</b>	760 mm Hg

<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	178 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Fragrance Materials Association (FMA) Boiling point.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	185 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Fragrance Materials Association (FMA) Boiling point.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	185.8 °C

<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	172 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Fragrance Materials Association (FMA) Boiling point.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	167.7 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Measured



<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	44 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Merck Index (1996) 12th edition, Susan Budavari, editor, Merck & Co. Inc. Whitehouse Station, NJ.

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	165-168 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	CRC Handbook of Chemistry and Physics (1986) 67th edition, Robert C. Weast, editor, The Chemical Rubber Co Press, Inc. Boca Raton, FL.

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	158 °C
<b>Pressure</b>	760 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Fragrance Materials Association (FMA) Boiling point.

<b>Substance Name</b>	Terpenes & terpenoids, sweet orange oil
<b>CAS No.</b>	68647-72-3

<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Boiling Point</b>	176 °C
<b>Pressure</b>	1013 mm Hg
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Givaudan-Roure (1991) Unpublished report to RIFM.

### 1.3 Vapor Pressure

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Measured
<b>Vapor Pressure</b>	1.43 mmHg (0.19 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Only secondary literature (review, tables, books, etc.).
<b>References</b>	IPCS (1998) Concise International Chemical Assessment Document No. 5 Limonene. World Health Organization, 5, Geneva.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Calculated
<b>Vapor Pressure</b>	1.2 mm Hg (0.16 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Fragrance Materials Association (FMA) Report values for vapor pressure.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Calculated/Mean of Antoine & Grain
<b>Vapor Pressure</b>	1.59 mmHg (0.19 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	MPBPVPWIN EPI suite (2000) US Environmental Protection Agency.

<b>Substance Name</b>	<i>d</i> / <i>l</i> -Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Calculated/Mean of Antoine & Grain
<b>Vapor Pressure</b>	1.63 mm Hg (0.22 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	MPBPVPWIN EPI suite (2000) US Environmental Protection Agency.

<b>Substance Name</b>	<i>d</i> / <i>l</i> -Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Calculated
<b>Vapor Pressure</b>	0.8 mm Hg (0.1 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Fragrance Materials Association (FMA) Report values for vapor pressure.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9

<b>Method/guideline</b>	Calculated/Mean of Antoine & Grain
<b>Vapor Pressure</b>	1.44 mm Hg (0.19 kPa)
<b>Temperature</b>	25 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	MPBPV/PWIN EPI suite (2000) US Environmental Protection Agency.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Calculated
<b>Vapor Pressure</b>	0.5 mm Hg (0.07 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Fragrance Materials Association (FMA) Report values for vapor pressure.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Calculated
<b>Vapor Pressure</b>	1.5 mm Hg (0.2 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Fragrance Materials Association (FMA) Report values for vapor pressure.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Calculated/Mean of Antoine & Grain
<b>Vapor Pressure</b>	2.4 mm Hg (0.32 kPa)

<b>Temperature</b>	25 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	MPBPVPWIN EPI suite (2000) US Environmental Protection Agency.

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	Calculated/Mean of Antoine & Grain
<b>Vapor Pressure</b>	2.57 mm Hg (0.34 kPa)
<b>Temperature</b>	25 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	MPBPVPWIN EPI suite (2000) US Environmental Protection Agency.

<b>Substance Name</b>	Orange peel oil, sweet (Citrus sinensis (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	Calculated
<b>Vapor Pressure</b>	0.9 mm Hg (0.12 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Fragrance Materials Association (FMA) Report values for vapor pressure.

<b>Substance Name</b>	Terpenes & terpenoids, sweet orange oil
<b>CAS No.</b>	68647-72-3
<b>Method/guideline</b>	Calculated
<b>Vapor Pressure</b>	0.9 mm Hg (0.12 kPa)
<b>Temperature</b>	20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable

<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Fragrance Materials Association (FMA) Report values for vapor pressure.

#### 1.4 n-Octanol/Water Partition Coefficient

<b>Substance Name</b>	d-Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Measured
<b>GLP</b>	Ambiguous
<b>Log Pow</b>	4.23
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Only secondary literature (review, tables, books, etc.).
<b>References</b>	IPCS (1998) Concise International Chemical Assessment Document No. 5 Limonene. World Health Organization, 5, Geneva.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	OECD Guideline No. 117
<b>GLP</b>	Yes
<b>Year</b>	1996
<b>Log Pow</b>	5.3
<b>Temperature</b>	30 °C
<b>Remarks for Test Conditions</b>	Reverse phase HPLC
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	Givaudan Roure Inc. (1996a) Partition coefficient n-octanol/water of terpinolene. Private communication to RIFM.

<b>Substance Name</b>	Terpenes & terpenoids, sweet orange oil
<b>CAS No.</b>	68647-72-3

<b>Method/guideline</b>	OECD Guideline No. 117
<b>GLP</b>	Yes
<b>Year</b>	1996
<b>Log Pow</b>	5.3
<b>Temperature</b>	45 °C
<b>Remarks for Test Conditions</b>	Reverse phase HPLC
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	Givaudan Roure Inc. (1996b) Partition coefficient n-octanol/water of orange peel. Private communication to RIFM.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Calculated
<b>Log Pow</b>	4.83
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Syracuse Research Corporation (SRC) Private communication to FMA.

<b>Substance Name</b>	<i>d</i> /Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Calculated
<b>Log Pow</b>	4.83
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Syracuse Research Corporation (SRC) Private communication to FMA.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Calculated

<b>Log Pow</b>	4.88
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Syracuse Research Corporation (SRC) Private communication to FMA.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-11-5
<b>Method/guideline</b>	Calculated
<b>Log Pow</b>	4.88
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Syracuse Research Corporation (SRC) Private communication to FMA.

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	Calculated
<b>Log Pow</b>	4.88
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	Syracuse Research Corporation (SRC) Private communication to FMA.

## 1.5 Water Solubility

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Experimental
<b>Value (mg/L) at Temperature</b>	13.8 mg/L at 25 °C
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Comparable to guideline study.



**References**

WSKOWWIN EPI Suite (2000c) US Environmental Protection Agency (Massaldi, HA & King, CJ, 1973).

<b>Substance Name</b>	<i>d</i> -Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Experimental
<b>Value (mg/L) at Temperature</b>	13.8 mg/L at 25 °C
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Comparable to guideline study.
<b>References</b>	WSKOWWIN EPI Suite (2000c) US Environmental Protection Agency (Massaldi, HA & King, CJ, 1973).

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Experimental
<b>Value (mg/L) at Temperature</b>	9.5 mg/L at 23 °C
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Comparable to guideline study.
<b>References</b>	WSKOWWIN EPI Suite (2000b) US Environmental Protection Agency (Li, J. and Perdue, EM, 1995).

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Experimental
<b>Value (mg/L) at Temperature</b>	5.6 mg/L at 25 °C
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Comparable to guideline study.
<b>References</b>	WSKOWWIN EPI Suite (2000a) US Environmental Protection Agency (Chem Inspect Test Inst, 1992).

<b>Substance Name</b>	Terpenes & terpenoids, sweet orange oil
<b>CAS No.</b>	68647-72-3
<b>Method/guideline</b>	Experimental

<b>Value (mg/L) at Temperature</b>	30 mg/L at 20 °C
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Comparable to guideline study with acceptable restrictions.
<b>References</b>	Givaudan-Roure (1991) Unpublished report to RIFM.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Calculated
<b>Value (mg/L) at Temperature</b>	0.74 mg/L at 25 °C
<b>Remarks for Test Conditions</b>	Input parameters: Log Kow, 5.3; Melting Point, -74.35
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	WSKOWWIN EPI Suite (2000d) US Environmental Protection Agency.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Calculated
<b>Value (mg/L) at Temperature</b>	1.87mg/L at 25 °C
<b>Remarks for Test Conditions</b>	Input parameters: Log Kow, 4.88; Melting Point, -29.5
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	WSKOWWIN EPI Suite (2000d) US Environmental Protection Agency.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Calculated
<b>Value (mg/L) at Temperature</b>	1.87 mg/L at 25 °C
<b>Remarks for Test Conditions</b>	Input parameters: Log Kow, 4.88; Melting Point, -64.83
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	WSKOWWIN EPI Suite (2000d) US Environmental Protection Agency.

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	Calculated
<b>Value (mg/L) at Temperature</b>	1.87 mg/L at 25 °C
<b>Remarks for Test Conditions</b>	Input parameters: Log Kow, 4.88; Melting Point, -66.0
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	WSKOWWIN EPI Suite (2000d) US Environmental Protection Agency.

<b>Substance Name</b>	<i>d</i> -Limonene (dipentene)
<b>CAS No.</b>	138-86-3
<b>Method/guideline</b>	Calculated
<b>Value (mg/L) at Temperature</b>	0.74 mg/L at 25 °C
<b>Remarks for Test Conditions</b>	Input parameters: Log Kow, 5.3; Melting Point, -97
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	WSKOWWIN EPI Suite (2000d) US Environmental Protection Agency.

## 2 Environmental Fate and Pathways

### 2.1 Photodegradation

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Calculated
<b>Test Type</b>	AOPWIN
<b>Half-life t<sub>1/2</sub></b>	0.884 hours
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	AOPWIN EPI Suite (2000) US Environmental Protection Agency.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Calculated
<b>Test Type</b>	AOPWIN
<b>Half-life t<sub>1/2</sub></b>	0.64 hours
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>References</b>	AOPWIN EPI Suite (2000) US Environmental Protection Agency.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Calculated
<b>Test Type</b>	AOPWIN
<b>Half-life t<sub>1/2</sub></b>	0.66 hours
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.

**References**

AOPWIN EPI Suite (2000) US Environmental Protection Agency.

**2.2 Biodegradation**

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	97% purity
<b>Method</b>	Not given
<b>Test Type</b>	Sealed vessel
<b>GLP</b>	Ambiguous
<b>Year</b>	1996
<b>Contact Time</b>	30 days
<b>Innoculum</b>	Unacclimated soil from coniferous forest
<b>Remarks for Test Conditions</b>	Limonene was tested in concentrations of 0.5-3 mg/liter, in sealed reactors. After 24 hours equilibration, inocula were added at 1%. Incubation took place in the dark at 23 degrees Celsius with continuous mixing. Duplicate gas and liquid samples were taken at regular intervals and analyzed for monoterpenes and CO <sub>2</sub> .
<b>Degradation % After Time</b>	0.044 mg/l h maximum degradation rate
<b>Time required for 10% degradation</b>	Less than 1 day
<b>Results</b>	Terpinolene was depleted below detectable limits within 1 day in acclimated soil and 8 days in unacclimated soil.
<b>Classification</b>	Readily biodegradable
<b>Conclusion Remarks</b>	The increase in biomass and headspace CO <sub>2</sub> parallel the depletion of limonene, confirming that the disappearance of limonene was a result of biodegradation.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>Reference</b>	Misra G., Pavlostathis S., Perdue E., Araujo R. (1996) Aerobic biodegradation of selected monoterpenes. Appl Microbiol Biotechnol 45: 831-838.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method</b>	OECD Method 301B

<b>Test Type</b>	Sealed vessel carbon dioxide production test
<b>GLP</b>	Yes
<b>Year</b>	1996
<b>Contact Time</b>	28 days
<b>Innoculum</b>	Secondary effluent from an unacclimatized activated sludge plant
<b>Remarks for Test Conditions</b>	Nominal carbon concentrations of the test substances were used based on the calculated percentage carbon and assuming 100% purity of the named compound (1062 micrograms of carbon for terpinolene). The testing procedure followed OECD 301B.
<b>Degradation % After Time</b>	62.1% (95% C.I. 33.3-90.8) after 28 days
<b>Time required for 10% degradation</b>	Less than 3 days
<b>Remarks Results</b>	The air temperature during the 28 day test period was 19-24 degrees Celsius.
<b>10 day window criteria</b>	63.6%
<b>Classification</b>	PASS- readily and ultimately biodegradable
<b>Conclusion Remarks</b>	The test substance, terpinolene, was considered ultimately and readily biodegradable.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Comparable to guideline study.
<b>Reference</b>	Birch R.R. (1996) The ultimate biodegradability of terpinolene in the Sealed Vessel Test. Private Communication to FFHPVC.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Remarks for Substance</b>	82.2% pure by GC; almost colorless to pale yellow liquid; density 0.875 g/ml at 20 degrees Celsius
<b>Method</b>	OECD Method 302C
<b>Test Type</b>	Inherent Biodegradability: Manometric Respirometry Test
<b>GLP</b>	Yes
<b>Year</b>	1998
<b>Contact Time</b>	31 days
<b>Innoculum</b>	Fresh activated sludge
<b>Remarks for Test Conditions</b>	Followed OECD Method No. 302C. The reference substance used was sodium benzoate. The concentration of test substance used was 30 mg/l. The test temperature was 25 degrees Celsius.

<b>Degradation % After Time</b>	80% after 31 days (also 80% after 28 days)
<b>Time required for 10% degradation Results</b>	Less than 5 days  The % degradation (mean of 2 identical flasks) after 5 days is 52%; 7 days is 54%; 14 days is 74%; 21 days is 80%; 28 days is 80% and 31 days is 80%.
<b>10 day window criteria</b>	Not given
<b>Classification</b>	Inherently biodegradable
<b>Breakdown products (transient or stable)</b>	Not given
<b>Remarks fields for results</b>	Averages of 2 identical flasks were used to determine the results. Degradation of sodium benzoate was 65% after 7 days and 86% after 14 days; the activity of the inoculum thus verified.
<b>Conclusion Remarks</b>	The test substance, terpinolene, underwent 80% biodegradation after 31 days under the test conditions and is considered inherently biodegradable.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>Reference</b>	Rudio J. (1998) Inherent biodegradability of terpinolene according to OECD Guideline No. 302C. Private communication to FFHPVC.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method</b>	OECD Method 301F
<b>Test Type</b>	Ready Biodegradability: Manometric Respirometry Test
<b>GLP</b>	Yes
<b>Year</b>	1997
<b>Contact Time</b>	28 days
<b>Innoculum</b>	Fresh activated sludge
<b>Remarks for Test Conditions</b>	Followed OECD Method No. 301F. The reference substance used was sodium benzoate. The concentration of test substance used was 100 mg/l and the test temperature was 22 degrees Celsius.
<b>Degradation % After Time</b>	51% degradation after 28 days
<b>Time required for 10% degradation Results</b>	Less than 2 days  The % degradation (mean of 2 identical flasks) after 2 days is 11%; 7 days is 31%; 12 days is 47%; 14 days is 49%; 21 days is 50% and 28 days is 51%.
<b>10 day window criteria</b>	47% at end of 10 day window (days 2 to 12)

<b>Classification</b>	Not readily biodegradable
<b>Breakdown products (transient or stable)</b>	Not given
<b>Remarks fields for results</b>	No toxic effects of terpinolene were observed on the microorganisms.
<b>Conclusion Remarks</b>	Terpinolene, which underwent 51% biodegradation after 28 days, should be regarded as not readily biodegradable under the conditions outlined for this test.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>Reference</b>	Rudio J. (1997) Ready biodegradability of pinene <i>alpha</i> according to OECD Guideline No. 301F. Private communication to FFHPVC.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Remarks for Substance</b>	97% purity
<b>Method</b>	Not given
<b>Test Type</b>	Sealed vessel
<b>GLP</b>	Ambiguous
<b>Year</b>	1996
<b>Contact Time</b>	30 days
<b>Innoculum</b>	Unacclimated soil from coniferous forest
<b>Remarks for Test Conditions</b>	Terpinolene was tested in concentrations of 0.5-3 mg/liter, in sealed reactors. After 24 hours equilibration, inocula were added at 1%. Incubation took place in the dark at 23 degrees Celsius with continuous mixing. Duplicate gas and liquid samples were taken at regular intervals and analyzed for monoterpenes and CO <sub>2</sub> .
<b>Degradation % After Time</b>	0.053 mg/l h maximum degradation rate
<b>Time required for 10% degradation</b>	Less than 1 day
<b>Results</b>	Limonene was depleted below detectable limits within 1 day in acclimated soil and 8 days in unacclimated soil.
<b>Classification</b>	Readily biodegradable
<b>Conclusion Remarks</b>	The increase in biomass and headspace CO <sub>2</sub> parallel the depletion of terpinolene, confirming that the disappearance of terpinolene was a result of biodegradation.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.



**Reference**

Misra G., Pavlostathis S., Perdue E., Araujo R. (1996) Aerobic biodegradation of selected monoterpenes. Appl Microbiol Biotechnol 45: 831-838.

**2.3 Fugacity**

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Soil-Water Partition Coefficient
<b>Absorption coefficient</b>	731
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Sediment-Water Partition Coefficient
<b>Absorption coefficient</b>	1462
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Suspended Sediment-Water Partition Coefficient
<b>Absorption coefficient</b>	4570
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Air-Water Partition Coefficient
<b>Absorption coefficient</b>	1.05
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Fish-Water Partition Coefficient
<b>Absorption coefficient</b>	1858
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Aerosol-Air Partition Coefficient
<b>Absorption coefficient</b>	22700
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Air
<b>Estimated Distribution and Media Concentration</b>	93.8%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Water
<b>Estimated Distribution and Media Concentration</b>	0.18%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Soil
<b>Estimated Distribution and Media Concentration</b>	5.87%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Sediment
<b>Estimated Distribution and Media Concentration</b>	0.13%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Suspended Sediment
<b>Estimated Distribution and Media Concentration</b>	0.0041%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Fish
<b>Estimated Distribution and Media Concentration</b>	0.00033%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Aerosol
<b>Absorption coefficient</b>	0.000043%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Air-Water Partition Coefficient
<b>Absorption coefficient</b>	0.57
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Sediment-Water Partition Coefficient
<b>Absorption coefficient</b>	1162
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Suspended Sediment-Water Partition Coefficient
<b>Absorption coefficient</b>	3630
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.



<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, calculated MP, water solubility
<b>Media</b>	Soil-Water Partition Coefficient
<b>Absorption coefficient</b>	581
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, VP, log Kow, MP, water solubility
<b>Media</b>	Fish-Water Partition Coefficient
<b>Absorption coefficient</b>	1477
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Aerosol-Air Partition Coefficient
<b>Absorption coefficient</b>	60600
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Air
<b>Estimated Distribution and Media Concentration</b>	91.2%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Water
<b>Estimated Distribution and Media Concentration</b>	0.32%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Soil
<b>Estimated Distribution and Media Concentration</b>	8.32%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Sediment
<b>Estimated Distribution and Media Concentration</b>	0.18%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Suspended Sediment
<b>Estimated Distribution and Media Concentration</b>	0.0058%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Fish
<b>Estimated Distribution and Media Concentration</b>	0.00047%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Aerosol
<b>Estimated Distribution and Media Concentration</b>	0.000011%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Air-Water Partition Coefficient
<b>Absorption coefficient</b>	2.64
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Soil-Water Partition Coefficient
<b>Absorption coefficient</b>	291
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Sediment-Water Partition Coefficient
<b>Absorption coefficient</b>	582
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Suspended Sediment-Water Partition Coefficient
<b>absorption coefficient</b>	1820
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Fish-Water Partition Coefficient
<b>Absorption coefficient</b>	740
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Aerosol-Air Partition Coefficient
<b>Absorption coefficient</b>	22300
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.



<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Air
<b>Estimated Distribution and Media Concentration</b>	98.9%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Water
<b>Estimated Distribution and Media Concentration</b>	0.075%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Soil
<b>Estimated Distribution and Media Concentration</b>	0.098%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Sediment
<b>Estimated Distribution and Media Concentration</b>	0.022%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Suspended Sediment
<b>Estimated Distribution and Media Concentration</b>	0.00068%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Fish
<b>Estimated Distribution and Media Concentration</b>	0.000056%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Model Conditions</b>	25 °C, 100,000
<b>Test Type</b>	Environmental Equilibrium Partitioning Model
<b>Method</b>	Mackay
<b>Model Used</b>	EQC V 2.11 Level I
<b>Input Parameters</b>	MW, log Kow, water solubility, VP & calculated MP
<b>Media</b>	Aerosol
<b>Estimated Distribution and Media Concentration</b>	0.000044%
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated. The data are obtained by a recognized fugacity calculation method.
<b>References</b>	Trent University (1999) Level 1 Fugacity-based Environmental Equilibrium Partitioning Model Version 2.11. Based on Mackay, Donald (1991) Multimedia environmental models: The fugacity approach. Lewis Publications, CRC Press, Boca Raton, FL.

### 3 Ecotoxicity

#### 3.1 Acute Toxicity to Fish

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	<i>d</i> -Limonene in neat form had purity of 99%, in toxicant saturated water of 85%, in exposure water 67%
<b>Method/guideline</b>	Flow-through. Calculated LC50 and EC50 using the Trimmed Spearman-Kärber Method [Hamilton <i>et al.</i> , 1977] and corrected average of the analyzed tank concentrations
<b>Test Type</b>	Experimental
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain/Supplier</b>	Fathead minnows/Fluorostat Corporation
<b>Exposure Period</b>	96 hour
<b>Analytical monitoring</b>	GC Analysis
<b>Remarks for Test Conditions</b>	96 hour LC50 and EC50 tests were performed with fathead minnows using <i>d</i> -limonene from two different suppliers. Test protocol was a continuous flow-through system. Tests were conducted in the electronic diluter using 0.2 L test chambers. A saturator flow rate of 21 ml/min resulted in exposure concentrations of 251 to 1890 ug/L.
<b>Endpoint value</b>	LC50 = 720 ug/L 95% C.L. (618-839 ug/L) and EC50=688 ug/L 95% C.L.(606-782 ug/L).
<b>Measured concentrations as mg/L</b>	2.73 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>Reference</b>	Broderius S. (1990) Toxicity of Eight Terpenes to Fathead Minnows, Daphnids, and Algae. U.S. EPA Environmental Research Laboratory-Duluth and ASCI Corporation.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	<i>d</i> -Limonene in neat form had purity of 99%, in toxicant saturated water of 85%, in exposure water 67%
<b>Method/guideline</b>	Flow-through. Calculated LC50 and EC50 using the Trimmed Spearman-Kärber Method [Hamilton <i>et al.</i> , 1977] and corrected average of the analyzed tank concentrations

<b>Test Type</b>	Experimental
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain/Supplier</b>	Fathead minnows/Aldrich Chemical
<b>Exposure Period</b>	96 hour
<b>Analytical monitoring</b>	GC Analysis
<b>Remarks for Test Conditions</b>	96 hour LC50 and EC50 tests were performed with fathead minnows using <i>d</i> -limonene from two different suppliers. Test protocol was a continuous flow-through system. Tests were conducted in the electronic diluter using 0.2 L test chambers. A saturator flow rate of 21 mls/min resulted in exposure concentrations of 178 to 1350 ug/L.
<b>Endpoint value</b>	LC50 = 702 ug/L 95% C.L. (619-796 ug/L) and EC50=702 ug/L 95% C.L.(619-796 ug/L).
<b>Measured concentrations as mg/L</b>	1.81 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>Reference</b>	Broderius S. (1990) Toxicity of Eight Terpenes to Fathead Minnows, Daphnids, and Algae. U.S. EPA Environmental Research Laboratory-Duluth and ASCI Corporation.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Remarks for Substance</b>	Terpinolene in neat form had purity of >99%, in toxicant saturated water of 75% purity, in exposure water 41% purity
<b>Method/guideline</b>	Calculated LC50 and EC50 using the Trimmed Spearman-Kärber Method [Hamilton <i>et al.</i> , 1977] and corrected average of the analyzed tank concentrations
<b>Test Type</b>	Experimental
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain/Supplier</b>	Fathead minnows/American Tokyo Kasei
<b>Exposure Period</b>	96 hour
<b>Analytical monitoring</b>	GC Analysis
<b>Remarks for Test Conditions</b>	96 hour LC50 and EC50 tests were performed with fathead minnows using terpinolene. Test protocol was a continuous flow-through system. Tests were conducted in the electronic diluter using 0.2 L test chambers. A saturator flow rate of 21 mL/min resulted in exposure concentrations of 279 to 3020 ug/L.

<b>Endpoint value</b>	LC50 = 720 ug/L 95% C.L. (618-839 ug/L) and EC50=688 ug/L 95% C.L.(606-782 ug/L).
<b>Measured concentrations as mg/L</b>	3.38 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>Reference</b>	Broderius S. (1990) Toxicity of Eight Terpenes to Fathead Minnows, Daphnids, and Algae. U.S. EPA Environmental Research Laboratory-Duluth and ASCI Corporation.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Fish
<b>Exposure Period</b>	96 hour
<b>Remarks for Test Conditions</b>	Input parameters: Melting point, -74.35, Water solubility - 13.8 mg/L, Log Kow - 5.3
<b>Endpoint value</b>	LC50 = 0.221 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	138-86-3
<b>CAS No.</b>	<i>d</i> /-Limonene (dipentene)
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Fish
<b>Exposure Period</b>	96 hour
<b>Remarks for Test Conditions</b>	Input parameters: Melting point, -74.35, Water solubility - 13.8 mg/L, Log Kow - 5.3
<b>Endpoint value</b>	LC50 = 0.221 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.

<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).
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<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Fish
<b>Exposure Period</b>	96 hour
<b>Remarks for Test Conditions</b>	Input parameters: Melting point, -29.50, Water solubility - 9.5 mg/L, Log Kow - 4.88
<b>Endpoint value</b>	LC50 = 0.198 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Fish
<b>Exposure Period</b>	96 hour
<b>Remarks for Test Conditions</b>	Input parameters: Melting point, -64.83, Water solubility - 5.6mg/L, Log Kow - 4.8
<b>Endpoint value</b>	LC50 = 0.198 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	ECOSAR



<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Fish
<b>Exposure Period</b>	96 hour
<b>Remarks for Test Conditions</b>	Input parameters: Melting point, -66.11, Log Kow - 4.88
<b>Endpoint value</b>	LC50 = 0.201 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

### 3.2 Acute Toxicity to Aquatic Invertebrates

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	<i>d</i> -Limonene in neat form had purity of 99%, in toxicant saturated water of 85%, in exposure water 67%
<b>Method/guideline</b>	Flow-through. Calculated LC50 and EC50 using the Trimmed Spearman-Kärber Method [Hamilton <i>et al.</i> , 1977] and corrected average of the analyzed tank concentrations
<b>Test Type</b>	Experimental
<b>GLP</b>	No
<b>Species/Strain/Supplier</b>	<i>Daphnia Magna</i>
<b>Analytical procedures</b>	GC Analysis
<b>Test Details</b>	96 hours
<b>Remarks for Test Conditions</b>	96 hour LC50 and EC50 tests were performed with daphnia magna from two different suppliers. Test protocol was a continuous flow-through system. Tests were conducted in the electronic diluter using 0.2 L test chambers. A saturator flow rate of 21 mL/min resulted in exposure concentrations of 251 to 1890 ug/L.
<b>Measured concentrations as mg/L</b>	2.73 mg/L
<b>EC50, EL50, LC0, at 24,48 hours</b>	96 hr LC50 = .577 mg/L 95% C.L. (496-672 ug/L) and EC50=421 ug/L (no reliable confidence limits)
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Data Reliability Remarks</b>	Code 1. Guideline study.
<b>Reference</b>	U.S. EPA Environmental Research Laboratory-Duluth and ASCI Corporation.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	<i>d</i> -Limonene in neat form had purity of 99%, in toxicant saturated water of 85%, in exposure water 67%
<b>Method/guideline</b>	Calculated LC50 and EC50 using the Trimmed Spearman-Kärber Method [Hamilton <i>et al.</i> , 1977] and corrected average of the analyzed tank concentrations
<b>Test Type</b>	Experimental
<b>GLP</b>	No
<b>Species/Strain/Supplier</b>	<i>Daphnia Magna</i>
<b>Analytical procedures</b>	GC Analysis
<b>Test Details</b>	96 hours
<b>Remarks for Test Conditions</b>	96 hour LC50 and EC50 tests were performed with daphnia magna using <i>d</i> -limonene from two different suppliers. Test protocol was a continuous flow-through system. Tests were conducted in the electronic diluter using 0.2 L test chambers. A saturator flow rate of 21 mL/min resulted in exposure concentrations of 178 to 1350 ug/L.
<b>Measured concentrations as mg/L</b>	1.81 mg/L
<b>EC50, EL50, LC0, at 24,48 hours</b>	96 hr LC50 = .924 mg/L (no reliable confidence limits)
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Data Reliability Remarks</b>	Code 1. Guideline study.
<b>Reference</b>	U.S. EPA Environmental Research Laboratory-Duluth and ASCI Corporation.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	97% purity
<b>Method/guideline</b>	Static. EC50
<b>Test Type</b>	Experimental
<b>GLP</b>	Ambiguous
<b>Year</b>	1987
<b>Species/Strain/Supplier</b>	<i>Daphnia pulex</i>
<b>Analytical procedures</b>	GC Analysis

<b>Test Details</b>	48 hours
<b>Remarks for Test Conditions</b>	The 48 hour static acute tests with <i>Daphnia pulex</i> were conducted without feeding the organisms. Tests included a water or solvent control and five concentrations of toxicant dissolved in water or toxicant. Tests chambers contained at least 10 neonates in 150 ml of water. Two replicates were performed.
<b>EC50, EL50, LC0, at 24,48 hours</b>	EC50 = 69.6 mg/L at 48 hour
<b>Data Qualities Reliabilities</b>	Reliability code 3. Not reliable.
<b>Data Reliability Remarks</b>	Code 3. Test concentration exceeds the limit of solubility of <i>d</i> -limonene.
<b>Reference</b>	Passino D.R., and Smith S. (1987) Acute bioassays and hazard evaluation of representative contaminants detected in great lakes fish. <i>Environmental Toxicology and Chemistry</i> , 6, 901.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Flow-through. Calculated LC50 and EC50 using the Trimmed Spearman-Kärber Method [Hamilton <i>et al.</i> , 1977] and corrected average of the analyzed tank concentrations
<b>Test Type</b>	Experimental
<b>GLP</b>	No
<b>Species/Strain/Supplier</b>	<i>Daphnia Magna</i>
<b>Analytical procedures</b>	GC Analysis
<b>Test Details</b>	96 hours
<b>Remarks for Test Conditions</b>	96 hour LC50 and EC50 tests were performed with <i>daphnia magna</i> using terpinolene. Test protocol was a continuous flow-through system. Tests were conducted in the electronic diluter using 0.2 L test chambers. A saturator flow rate of 21 mL/min resulted in exposure concentrations of 279 to 3020 ug/L.
<b>Measured concentrations as mg/L</b>	3.38 mg/L
<b>EC50, EL50, LC0, at 24,48 hours</b>	96 hr LC50 = 2.55 mg/L (no reliable confidence limits) and EC50=1380 ug/L (no reliable confidence limits)
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Data Reliability Remarks</b>	Code 1. Guideline study.
<b>Reference</b>	U.S. EPA Environmental Research Laboratory-Duluth and ASCI Corporation.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3

<b>Method/guideline</b>	EPA Committee on Methods for Toxicity Tests with Aquatic Organisms (without replicate concentrations)
<b>Test Type</b>	Experimental
<b>GLP</b>	Ambiguous
<b>Year</b>	1986
<b>Species/Strain/Supplier</b>	<i>Daphnia Magna</i>
<b>Test Details</b>	48 hours
<b>Remarks for Test Conditions</b>	200 ml of the test solution and 10 Daphnia were used. Dissolved oxygen and pH were determined initially and at 48 hour. Mortalities were recorded at 24 and 48 hour.
<b>EC50, EL50, LC0, at 24,48 hours</b>	LC50 = 31 mg/L at 48 hour
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Data Reliability Remarks</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>Reference</b>	Waggy G.L. and Blessing R.L. (1986) Private communication.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Brine shrimp lethality test [Meyer, 1982]
<b>Test Type</b>	Experimental
<b>GLP</b>	Ambiguous
<b>Year</b>	1998
<b>Species/Strain/Supplier</b>	Brine shrimp
<b>Analytical procedures</b>	GC Analysis
<b>Test Details</b>	24 hours
<b>Remarks for Test Conditions</b>	<p>The essential oil of <i>Apium graveolens</i> (celery) was analyzed by GC-MS. Components were isolated using dry column chromatography and low pressure liquid chromatography to isolate the hydrocarbon component and individual hydrocarbon compounds, respectively. The brine shrimp lethality test was performed using the crude volatile oil, the hydrocarbon and oxygenated fractions, and the isolated compounds. The results given here are for the respective isolated compounds as listed under Substance Name.</p> <p>Brine shrimp eggs were hatched in seawater and used after 48 hrs. Ten shrimps were added to three vials for each of the following doses (2, 50 and 200 ppm). The vials were prepared by thoroughly mixing with the allotted amount of artificial seawater to achieve the correct concentration. The number of</p>

<b>EC50, EL50, LC0, at 24,48 hours</b>	deaths out of 30 shrimps per dose were recorded after 24 hrs. LC50 values and corresponding 95% confidence intervals were determined. Compounds with LC50 values over 200 ppm were retested at 1000 ppm. LC50 values greater than 200 ppm were considered inactive for pure compounds. LC50 = 39.2 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Data Reliability Remarks</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>Reference</b>	Saleh M.M., Hashem F.A., Glombitza K.A. (1998) Cytotoxicity and invitro effects on human cancer cell lines of volatiles of Apium graveolens var. filicinum. Pharmaceutical Pharmacological Letters, 8(2), 97-99.

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	Brine shrimp lethality test [Meyer, 1982]
<b>Test Type</b>	Experimental
<b>GLP</b>	Ambiguous
<b>Year</b>	1998
<b>Species/Strain/Supplier</b>	Brine shrimp
<b>Analytical procedures</b>	GC Analysis
<b>Test Details</b>	24 hours
<b>Remarks for Test Conditions</b>	<p>The essential oil of Apium graveolens (celery) was analyzed by GC-MS. Components were isolated using dry column chromatography and low pressure liquid chromatography to isolate the hydrocarbon component and individual hydrocarbon compounds, respectively. The brine shrimp lethality test was performed using the crude volatile oil, the hydrocarbon and oxygenated fractions, and the isolated compounds. The results given here are for the respective isolated compounds as listed under Substance Name.</p> <p>Brine shrimp eggs were hatched in seawater and used after 48 hrs. Ten shrimps were added to three vials for each of the following doses (2, 50 and 200 ppm). The vials were prepared by thoroughly mixing with the allotted amount of artificial seawater to achieve the correct concentration. The number of deaths out of 30 shrimps per dose were recorded after 24 hrs. LC50 values and corresponding 95% confidence intervals were determined. Compounds with LC50 values over 200 ppm were retested at 1000 ppm. LC50 values greater than 200 ppm were considered inactive for pure compounds. LC50 =104.1 mg/L</p>
<b>EC50, EL50, LC0, at 24,48 hours</b>	

<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Data Reliability Remarks</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>Reference</b>	Saleh M.M., Hashem F.A., Glombitza K.A. (1998) Cytotoxicity and invitro effects on human cancer cell lines of volatiles of <i>Apium graveolens</i> var. <i>filicinum</i> . Pharmaceutical Pharmacological Letters, 8(2), 97-99.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	<i>Daphnia Magna</i>
<b>Test Details</b>	48 hours
<b>EC50, EL50, LC0, at 24,48 hours</b>	LC50 = 0.496 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Data Reliability Remarks</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	<i>Daphnia Magna</i>
<b>Test Details</b>	48 hours
<b>EC50, EL50, LC0, at 24,48 hours</b>	LC50 = 0.612 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Data Reliability Remarks</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3

<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	<i>Daphnia Magna</i>
<b>Test Details</b>	48 hours
<b>EC50, EL50, LC0, at 24,48 hours</b>	LC50 = 1.147 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Data Reliability Remarks</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	<i>Daphnia Magna</i>
<b>Test Details</b>	48 hours
<b>EC50, EL50, LC0, at 24,48 hours</b>	LC50 = 0.263 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Data Reliability Remarks</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

### 3.3 Acute Toxicity to Aquatic Plants

<b>Substance Name</b>	d-Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	d-Limonene in neat form had purity of 99%, in toxicant saturated water of 85%, in exposure water 67%
<b>Method/guideline</b>	ASTM methods (ASTM, 1988)
<b>Test Type</b>	Static 96 hour toxicity test with micro algae
<b>GLP</b>	Ambiguous
<b>Year</b>	1990

<b>Species/Strain/Supplier</b>	Green algae/ <i>Selenastrum capricornutum</i>
<b>Exposure Period</b>	96 hour
<b>Analytical monitoring</b>	GC analysis
<b>Remarks for Test Conditions</b>	Test conditions followed ASTM methods. Changes were made to help reduce any problems associated with volatility. GC analysis was performed at 0, 24, and 96 hours. The 96 hour sample was performed only if the chemical was detected at the 24 hour sampling. Test cell concentrations were approximately 10000 cells/mL. Coulter counters and electronic particle counter were used to count cells and determine mean cell volume. The IC50 (the concentration at which 50% growth inhibition) was calculated using a linear interpolation program.
<b>Nominal concentrations as mg/L</b>	Not given
<b>Measured concentrations as mg/L</b>	1.81 mg/L
<b>Endpoint value</b>	No significant inhibition
<b>Conclusion Remarks</b>	No significant inhibition.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>Reference</b>	Broderius S. (1990) Toxicity of Eight Terpenes to Fathead Minnows, Daphnids, and Algae. U.S. EPA Environmental Research Laboratory-Duluth and ASCI Corporation.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Remarks for Substance</b>	Terpinolene in neat form had purity of >99%, in toxicant saturated water of 75% purity, in exposure water 41% purity
<b>Method/guideline</b>	ASTM methods (ASTM, 1988)
<b>Test Type</b>	Static 96 hour toxicity test with micro algae
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain/Supplier</b>	Green algae/ <i>Selenastrum capricornutum</i>
<b>Exposure Period</b>	96 hour
<b>Analytical monitoring</b>	GC analysis
<b>Remarks for Test Conditions</b>	Test conditions followed ASTM methods. Changes were made to help reduce any problems associated with volatility. GC analysis was performed at 0, 24, and 96 hours. The 96 hour sample was performed only if the chemical was detected at the 24 hour sampling. Test cell concentrations were approximately 10000 cells/mL. Coulter counters and electronic particle counter



	were used to count cells and determine mean cell volume. The IC50 (the concentration at which 50% growth inhibition) was calculated using a linear interpolation program.
<b>Nominal concentrations as mg/L</b>	Not given
<b>Measured concentrations as mg/L</b>	3.38 mg/L
<b>Endpoint value</b>	No significant inhibition
<b>Conclusion Remarks</b>	No significant inhibition.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>Reference</b>	Broderius S. (1990) Toxicity of Eight Terpenes to Fathead Minnows, Daphnids, and Algae. U.S. EPA Environmental Research Laboratory-Duluth and ASCI Corporation.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Green algae
<b>Exposure Period</b>	96 hours
<b>Endpoint value</b>	EC50 = 0.360 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Green algae
<b>Exposure Period</b>	96 hours
<b>Endpoint value</b>	EC50 = 0.813 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.

**Remarks for Data Reliability** Code 4. Calculated.

**Reference** ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Green algae
<b>Exposure Period</b>	96 hours
<b>Endpoint value</b>	EC50 = 0.441 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	ECOSAR
<b>Test Type</b>	Calculated
<b>Species/Strain/Supplier</b>	Green algae
<b>Exposure Period</b>	96 hours
<b>Endpoint value</b>	EC50 = 0.194 mg/L
<b>Data Qualities Reliabilities</b>	Reliability code 4. Not assignable.
<b>Remarks for Data Reliability</b>	Code 4. Calculated.
<b>Reference</b>	ECOSAR EPI Suite (2000) U.S. Environmental Protection Agency (Nabholz V. and G. Cash, 1998).

## 4 Human Health Toxicity

### 4.1 Acute Toxicity

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Litchfield and Wilcoxon, 1949
<b>Test Type</b>	Oral LD 50
<b>GLP</b>	No
<b>Year</b>	1975
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Male and Female
<b># of animals per sex per dose</b>	10 male 10 female
<b>Vehicle</b>	Arabic gum/water
<b>Route of Administration</b>	Oral
<b>Remarks for Test Conditions</b>	Ten male and ten female rats per group were used.
<b>Value LD50 or LC50 with confidence limits</b>	Male LD50 = 4400 (3400-5900) mg/kg bw (95% confidence limit) and female LD50= 5.2 (3.9-7.0) g/kg bw (95% confidence limit)
<b>Number of deaths at each dose level</b>	1500 mg/kg NOE in males. Not tested in females. 1900 mg/kg LTL 30% mortality in males. No observed effects in females. 2500 mg/kg LTL 30% mortality in males. 20% mortality in females. 3.3 g/kg LTL 40% mortality in males. 50% mortality in females. 4.3 g/kg LTL 60% mortality in males. 40% mortality in females. 4.4 g/kg LD50 male rats. 95% Confidence limits (3.4-5.9). 5.2 g/kg LD50 female rats. 95% Confidence limits (3.9-7.0). 5.6 g/kg LTL 40% mortality in males. 50% mortality in females. 7.3 g/kg LTL 90% mortality in males. 60% mortality in females. 9.4 g/kg LTL 70% mortality in males. 60% mortality in females. 12.2 g/kg LTL 80% mortality in males. 90% mortality in females. 15.9 g/kg LTL 90% mortality in males. 100% mortality in females.
<b>Remarks for Results</b>	The male LD50 = 4400 (3400-5900) mg/kg bw (95% confidence limits) and female LD50= 5200 (3900-7000) mg/kg bw (95% confidence limits).
<b>Conclusion remarks</b>	The male LD50 = 4400 (3400-5900) mg/kg bw (95% confidence limits) and female LD50= 5200 (3900-7000) mg/kg bw (95% confidence limits).
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.

## References

Tsuji M., Y.Fujisaki, Y.Arikawa, S.Masuda, S.Kinoshita, A.Okubo, K.Noda, H.Ide and Y.Iwanaga (1975a) Studies on *d*-limonene as a gallstone solubilizer: Acute and sub-acute toxicities. Journal Oyo Yakuri, 9, 387-401.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Litchfield and Wilcoxon, 1949
<b>Test Type</b>	Oral LD 50
<b>GLP</b>	No
<b>Year</b>	1975
<b>Species/strain</b>	Mouse
<b>Sex</b>	Male and Female
<b># of animals per sex per dose</b>	10 male 10 female
<b>Vehicle</b>	Arabic gum/water
<b>Route of Administration</b>	Oral
<b>Remarks for Test Conditions</b>	Ten male and ten female mice per group were used.
<b>Value LD50 or LC50 with confidence limits</b>	Male LD50 = 5600 (4800-6500) mg/kg bw (95% confidence limit) and female LD50 = 6600 (5500-7900) mg/kg bw (95% confidence limit)
<b>Number of deaths at each dose level</b>	3.0 g/kg NOE in male mice. 3.5 g/kg LTL 10% mortality in male mice. No observable effects in female mice. 4.3 g/kg LTL 20% mortality in female mice. No observable effects in male mice. 5.3 g/kg LTL 20% mortality in female mice. 30% mortality in male mice. 5.6 g/kg LD50 male mice. 95% confidence limits (4.8-6.5) 6.6 g/kg LD50 female mice. 95% confidence limits (5.5-7.9). 7.0 g/kg LTL 30% mortality in female mice. 60% mortality in male mice. 7.5 g/kg LTL 60% mortality in female mice. 90% mortality in male mice. 8.3 g/kg LTL 90% mortality in female mice. 100% mortality in male mice. 10.0 g/kg LTL 100% mortality in female mice.
<b>Remarks for Results</b>	The male LD50 = 5600 (4800-6500) mg/kg bw (95% confidence limits) and female LD50 = 6600 (5500-7900) mg/kg bw (95% confidence limits).
<b>Conclusion remarks</b>	Male LD50 = 4400 (3400-5900) mg/kg bw (95% confidence limit) and female LD50 = 5200 (3900-7000) mg/kg bw (95% confidence limits).
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Tsuji M., Y.Fujisaki, Y.Arikawa, S.Masuda, S.Kinoshita, A.Okubo, K.Noda, H.Ide and Y.Iwanaga (1975a) Studies on <i>d</i> -limonene as a gallstone solubilizer: Acute and sub-acute

toxicities. Journal Oyo Yakuri, 9, 387-401.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Oral LD 50
<b>GLP</b>	No
<b>Year</b>	1972
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Male
<b># of animals per sex per dose</b>	10
<b>Vehicle</b>	None
<b>Route of Administration</b>	Oral
<b>Remarks for Test Conditions</b>	Ten male albino Wistar rats per group were used. Animals were fasted for a minimum of 16 hours prior to administration of the test material. Animals weighed 200-250 grams. Following dosing the animals received food and water ad libitum. Observations for mortality were made at 1 and 6 hours after dosing and daily thereafter for 14 days. Toxic effects were also observed. Gross necropsies were performed on all survivors.
<b>Value LD50 or LC50 with confidence limits</b>	Greater than 5000 mg/kg bw
<b>Number of deaths at each dose level</b>	None
<b>Remarks for Results</b>	Animals experienced lethargy. No deaths occurred. Oral LD50 greater than 5000 mg/kg.
<b>Conclusion remarks</b>	Oral LD50 greater than 5000 mg/kg bw
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Moreno O. (1972c) Acute oral toxicity of limonene in rats. Unpublished report.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Oral LD 50

<b>GLP</b>	No
<b>Year</b>	1975
<b>Species/strain</b>	Rat
<b>Sex</b>	Not reported
<b># of animals per sex per dose</b>	10
<b>Vehicle</b>	None
<b>Route of Administration</b>	Oral
<b>Value LD50 or LC50 with confidence limits</b>	4.39 ml/kg 95% Confidence Limits (3.75-5.14 ml/kg)
<b>Number of deaths at each dose level</b>	3.0 ml/kg 0 deaths 3.5 ml/kg 1 death 4.0 ml/kg 5 deaths 5.0 ml/kg 6 deaths
<b>Remarks for Results</b>	The oral LD50 was calculated to be 4.39 ml/kg bw with 95% C.L. (3.75-5.14 ml/kg).
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Levenstein I. (1975) Oral LD 50 of terpinolene in rats. Unpublished report to RIFM.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Oral LD 50
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Male and Female
<b># of animals per sex per dose</b>	1 male 1 female except three highest doses
<b>Vehicle</b>	Corn oil
<b>Route of Administration</b>	Oral-Gavage
<b>Remarks for Test Conditions</b>	Two animals (1 male and 1 female) were used per dose with the exception of the three highest doses where 2 animals of each sex were used (see number of deaths at each dose level). Animals were fasted overnight prior to test administration. Animals were observed for 14 days following administration. Necropsies were performed on all animals.
<b>Value LD50 or LC50 with confidence limits</b>	Greater than 11.39 g/kg bw

<b>Number of deaths at each dose level</b>	0 g/kg bw Male 0/1 Female 0/1 0.67 g/kg bw Undefined results 1.00 g/kg bw Male 0/1 Female 0/1 1.5 g/kg bw Male 0/1 Female 0/1, 2.25 g/kg bw Male 0/1 Female 0/1 3.25 g/kg bw Male 0/1 Female 0/1 5.06 g/kg bw Male 0/2 Female 0/2 7.59 g/kg bw Male 0/2 Female 0/2 11.39 g/kg bw Male 0/2 Female 0/2
<b>Remarks for Results</b>	Animals at the three highest dose levels experienced palpebral ptosis, hypoactivity, and ataxia.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Paumgarten F.J.R. (1990) Single Dose Toxicity of <i>beta</i> -myrcene; a natural analgesic substance. Brazilian J Med Biol Res 23; 873-877.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Oral LD 50
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/strain</b>	Mouse/Albino Swiss
<b>Sex</b>	Male and Female
<b># of animals per sex per dose</b>	1 male 1 female with the exception of 2 doses
<b>Vehicle</b>	Corn oil
<b>Route of Administration</b>	Oral-Gavage
<b>Remarks for Test Conditions</b>	Two animals (1 male and 1 female) were used per dose with the exception of two doses where 3 animals of each sex were used (see number of deaths at each dose level). Animals were fasted overnight prior to test administration. Animals were observed for 14 days following administration. Necropsies were performed on all animals.
<b>Value LD50 or LC50 with confidence limits</b>	5060 mg/kg bw
<b>Number of deaths at each dose level</b>	0 g/kg bw Male 0/1 Female 0/1 0.67 g/kg bw Undefined results 1.00 g/kg bw Male 0/1 Female 0/1 1.5 g/kg bw Male 0/1 Female 0/1  2.25 g/kg bw Male 0/1 Female 0/1  3.25 g/kg bw Male 0/1 Female 0/1

	5.06 g/kg bw Male 2/3 Female 3/3
	7.59 g/kg bw Male 3/3 Female 2/3
	11.39 g/kg bw Male 1/1 Female 1/1
<b>Remarks for Results</b>	Animals at the three highest dose levels experienced palpebral ptosis, hypoactivity, and ataxia.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Paumgarten F.J.R. (1990) Single Dose Toxicity of <i>beta</i> -myrcene; a natural analgesic substance. Brazilian J Med Biol Res 23; 873-877.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Oral LD 50
<b>GLP</b>	No
<b>Year</b>	1972
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Male
<b># of animals per sex per dose</b>	10
<b>Vehicle</b>	None
<b>Route of Administration</b>	Oral
<b>Remarks for Test Conditions</b>	Ten male albino Wistar rats per group were used. Animals were fasted for a minimum of 16 hours prior to administration of the test material. Animals weighed 200-250 grams. Following dosing the animals received food and water ad libitum. Observations for mortality were made at 1 and 6 hours after dosing and daily thereafter for 14 days. Toxic effects were also observed. Gross necropsies were performed on all survivors.
<b>Value LD50 or LC50 with confidence limits</b>	Greater than 5000 mg/kg bw
<b>Number of deaths at each dose level</b>	1/10 deaths. Death occurred overnight following administration. Clinical signs included lethargy and urinary incontinence.



<b>Remarks for Results</b>	Animals experienced lethargy urinary incontinence. One deaths occurred. Oral LD50 greater than 5000 mg/kg.
<b>Conclusion remarks</b>	Oral LD50 greater than 5000 mg/kg.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Moreno O. (1972d) Acute oral toxicity of myrcene in rats. Unpublished report.

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	Litchfield and Wilcoxon, 1949
<b>Remarks for Substance</b>	Clear liquid
<b>Test Type</b>	Oral LD 50
<b>GLP</b>	No
<b>Year</b>	1980
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Male
<b># of animals per sex per dose</b>	10
<b>Vehicle</b>	None
<b>Route of Administration</b>	Oral
<b>Remarks for Test Conditions</b>	The rats were observed for 3-4 hours after dosing and once daily for 14 days. Mortality, toxicology, and pharmacological effects were recorded.
<b>Value LD50 or LC50 with confidence limits</b>	Greater than 5000 mg/kg bw
<b>Number of deaths at each dose level</b>	1 death at 5000 mg/kg bw
<b>Remarks for Results</b>	Lethargy and piloerection were noted 3-4 hours post dose. Most animals were generally healthy thereafter.
<b>Conclusion remarks</b>	Oral LD50 greater than 5000 mg/kg bw
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Moreno O. (1980b) Acute oral toxicity of dihydromyrcene in rats. Unpublished report.
<b>Substance Name</b>	Orange peel oil, sweet (Citrus sinensis (L.) Osbeck)

<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Oral LD 50
<b>GLP</b>	No
<b>Year</b>	1973
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Male
<b># of animals per sex per dose</b>	10
<b>Vehicle</b>	None
<b>Route of Administration</b>	Oral
<b>Remarks for Test Conditions</b>	The rats were observed for 3-4 hours after dosing and once daily for 14 days. Mortality, toxicology, and pharmacological effects were recorded.
<b>Value LD50 or LC50 with confidence limits</b>	Greater than 5000 mg/kg bw
<b>Remarks for Results</b>	The oral LD50 was determined to be greater than 5000 mg/kg bw.
<b>Conclusion remarks</b>	Oral LD50 >5000 mg/kg bw
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Moreno O. (1973b) Acute oral toxicity of orange oil in rats. Unpublished report.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Not given
<b>Remarks for Substance</b>	Clear liquid
<b>Test Type</b>	Dermal LD50
<b>GLP</b>	No
<b>Year</b>	1972
<b>Species/strain</b>	Rabbit/New Zealand White
<b>Sex</b>	Not reported
<b># of animals per sex per dose</b>	10

<b>Vehicle</b>	None
<b>Route of Administration</b>	Dermal
<b>Remarks for Test Conditions</b>	A single 24 hour application of limonene (5 g/kg) was applied to the clipped abraded abdominal skin of 10 rabbits weighing from 1.9 to 2.4 kg. Observations for mortality and toxic effects were made for seven days following exposure. Gross necropsies were performed on all animals at study termination.
<b>Value LD50 or LC50 with confidence limits</b>	Greater than 5000 mg/kg bw
<b>Number of deaths at each dose level</b>	None
<b>Remarks for Results</b>	No animals died during the study. Additionally, there was no evidence of toxicity resulting from application of the material.
<b>Conclusion remarks</b>	Oral LD50 greater than 5000 mg/kg bw
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Moreno O. (1972a) Acute dermal toxicity of limonene in rabbits. Unpublished report.

<b>Substance Name</b>	Dihydromyrcene
<b>CAS No.</b>	2436-90-0
<b>Method/guideline</b>	Litchfield and Wilcoxon, 1949
<b>Remarks for Substance</b>	Clear liquid
<b>Test Type</b>	Dermal LD50
<b>GLP</b>	No
<b>Year</b>	1980
<b>Species/strain</b>	Rabbit/New Zealand White
<b>Sex</b>	Male
<b># of animals per sex per dose</b>	10
<b>Vehicle</b>	None
<b>Route of Administration</b>	Dermal
<b>Remarks for Test Conditions</b>	A single 24 hour application of dihydromyrcene (5 g/kg) was applied to the clipped abraded abdominal skin of 10 rabbits. Observations for mortality and toxic effects were made for 14 days following exposure. All animals were examined for gross pathology.
<b>Value LD50 or LC50 with confidence limits</b>	Greater than 5000 mg/kg bw
<b>Number of deaths at each dose level</b>	1 death at 5000 mg/kg bw

<b>Remarks for Results</b>	Toxic signs noted infrequently included lethargy and diarrhea. Internal organs of surviving animals were normal following superficial examination. One animal showed signs of cardiac and respiratory abnormalities. Most also had skin abnormalities.
<b>Conclusion remarks</b>	Dermal LD50 >5000 mg/kg bw
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Moreno O. (1980b) Acute dermal toxicity of dihydromyrcene in rabbits. Unpublished report.

<b>Substance Name</b>	Terpinolene
<b>CAS No.</b>	586-62-9
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Dermal LD50
<b>GLP</b>	No
<b>Year</b>	1975
<b>Species/strain</b>	Rat
<b>Sex</b>	Not reported
<b># of animals per sex per dose</b>	4
<b>Vehicle</b>	None
<b>Route of Administration</b>	Dermal
<b>Value LD50 or LC50 with confidence limits</b>	Greater than 5 ml/kg bw
<b>Number of deaths at each dose level</b>	0 deaths
<b>Remarks for Results</b>	The dermal LD50 was determined to be greater than 5 ml/kg bw.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Levenstein I. (1975) Dermal LD 50 of terpinolene in rats. Unpublished report to RIFM.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Dermal LD50

<b>GLP</b>	No
<b>Year</b>	1972
<b>Species/strain</b>	Rabbit/New Zealand White
<b>Sex</b>	Not reported
<b># of animals per sex per dose</b>	10
<b>Vehicle</b>	None
<b>Route of Administration</b>	Dermal
<b>Remarks for Test Conditions</b>	A single 24 hour application of terpinolene (5 g/kg) was applied to the clipped abraded abdominal skin of 10 rabbits weighing from 1.9 to 2.4 kg. Observations for mortality and toxic effects were made for seven days following exposure. Gross necropsies were performed on all animals at study termination. Greater than 5000 mg/kg bw
<b>Value LD50 or LC50 with confidence limits</b>	
<b>Number of deaths at each dose level</b>	No deaths during the course of the study. No evidence of toxicity from percutaneous absorption of the test substance. Erythema and edema were reported during the first few days of observation, but cleared by the study termination.
<b>Remarks for Results</b>	The dermal LD50 was determined to be greater than 5000 mg/kg bw.
<b>Conclusion remarks</b>	Dermal LD50 greater than 5000 mg/kg bw
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Moreno O. (1972b) Acute dermal toxicity of myrcene in rabbits. Unpublished report.

<b>Substance Name</b>	Orange peel oil, sweet (Citrus sinensis (L.) Osbeck)
<b>CAS No.</b>	123-35-3
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Dermal LD50
<b>GLP</b>	No
<b>Year</b>	1973
<b>Species/strain</b>	Rabbit/New Zealand White
<b>Sex</b>	Male
<b># of animals per sex per dose</b>	10
<b>Vehicle</b>	None

<b>Route of Administration</b>	Dermal
<b>Remarks for Test Conditions</b>	A single 24 hour application of terpinolene (5 g/kg) was applied to the clipped abraded abdominal skin of 10 rabbits weighing from 1.9 to 2.4 kg. Observations for mortality and toxic effects were made for seven days following exposure. Gross necropsies were performed on all animals at study termination. Greater than 5000 mg/kg bw
<b>Value LD50 or LC50 with confidence limits</b>	
<b>Remarks for Results</b>	The dermal LD50 was determined to be greater than 5000 mg/kg bw.
<b>Conclusion remarks</b>	Dermal LD50 greater than 5.0 g/kg bw
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Moreno O. (1973a) Acute dermal toxicity of orange oil in rabbits. Unpublished report.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	Purity undetermined
<b>Method/guideline</b>	Not given
<b>Test Type</b>	Inhalation ED25
<b>GLP</b>	Not reported
<b>Year</b>	1977
<b>Species/strain</b>	Mouse
<b>Sex</b>	Female
<b># of animals per sex per dose</b>	5
<b>Vehicle</b>	None
<b>Route of Administration</b>	Inhalation
<b>Remarks for Test Conditions</b>	The respiratory irritation potential of fragrance raw materials was assessed in CF-1 females by recording respiratory rate using a whole body plethysmograph. Mice were exposed to test materials for 1 min using a nebulizer for aerosolization in a 2600 ml chamber. Materials shown to be sensory irritants were further tested in mice cannulated via the trachea & compared to an intact mouse breathing through its nose. Comparisons made were between the pre-exposure & exposure rate values for each material at each dose level. Materials were of undetermined purity. Respiratory tract, via nose, mild-moderate resp depression; ED25 = 570 ug/l; no effects when inhaled through tracheal cannula. (Troy, 1977) 9011

<b>Value LD50 or LC50 with confidence limits</b>	No ED25 determined.
<b>Number of deaths at each dose level</b>	None
<b>Remarks for Results</b>	Slight respiratory depression. Lower tract exposures not performed. No dose-response relationship.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restrictions.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Troy W.R. (1977) Doctoral Dissertation: The comparative respiratory irritation potential of fourteen fragrance raw materials. Unpublished report to RIFM.

## 4.2 Genetic Toxicity

### 4.2.1 In vitro Genotoxicity

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Ames test
<b>Test Type</b>	Ames reverse mutation
<b>System of Testing</b>	Bacterial
<b>GLP</b>	No
<b>Year</b>	1980
<b>Species/Strain</b>	<i>Salmonella typhimurium</i> TA 98, TA 100, TA 1535 and TA 1537
<b>Metabolic Activation</b>	With and without rat liver microsome fraction S9 from Aroclor induced rats
<b>Doses/Concentration</b>	0.03, 0.3, 3 and 30 micromol/plate for TA98 and TA100; 3 micromol/plate for the remaining strains
<b>Remarks for Test Conditions</b>	The solvent used was ethanol. Only one replicate was performed for the substances, which tested negative.
<b>Results</b>	No mutagenic effects.
<b>Cytotoxic concentration</b>	Greater than 3 micromoles/plate
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Limonene was inactive in <i>Salmonella</i> strains TA 1535, TA 1537, TA 98 & TA 100 both in the presence and absence of metabolic activation system.
<b>Conclusion Remarks</b>	No evidence of mutagenic activity.

<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Florin I., Rutberg L., Curvall M., and Enzell C.R. (1980) Screening of tobacco smoke constituents for mutagenicity using the Ames test. Toxicology, 18 pages 219-232.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Ames test
<b>Test Type</b>	Ames reverse mutation
<b>System of Testing</b>	Bacterial
<b>GLP</b>	No
<b>Year</b>	1989
<b>Species/Strain</b>	<i>Salmonella typhimurium</i> TA 98, TA 100, TA 1535, TA 1537, and TA1538
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced rats
<b>Doses/Concentration</b>	150000 micrograms/plate
<b>Remarks for Test Conditions</b>	After two days incubation at 37 °C, revertant colonies were counted.
<b>Results</b>	No mutagenic effects.
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Limonene was inactive in <i>Salmonella</i> strains TA 1535, TA 1537, TA 1538, TA 98 & TA 100 both in the presence and absence of metabolic activation system.
<b>Conclusion Remarks</b>	No evidence of mutagenicity.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Heck, J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989). An evaluation of food flavoring ingredients in a genetic toxicity screening battery The Toxicologist, 9(1), 257.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5



<b>Remarks for Substance</b>	Solvents used included DMSO and/or ethanol.
<b>Method/guideline</b>	Ames
<b>Test Type</b>	Ames reverse mutation
<b>System of Testing</b>	Bacterial
<b>GLP</b>	Ambiguous
<b>Year</b>	1993
<b>Species/Strain</b>	<i>Salmonella typhimurium</i> TA102
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced Sprague Dawley rats.
<b>Doses/Concentration</b>	Up to 5000 micrograms per plate
<b>Statistical Methods</b>	Not given
<b>Remarks for Test Conditions</b>	Limonene was tested in two independent experiments using five doses and three plates per dose. Solvents used for diluting the compounds were DMSO, ethanol and water. All compounds were tested up to 5000 micrograms per plate if possible unless limited by cytotoxicity or precipitation.
<b>Results</b>	Negative
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	Negative
<b>Appropriate statistical evaluations</b>	Not given
<b>Remarks for results</b>	Limonene was inactive in <i>Salmonella</i> strains TA 102 in the presence and absence of metabolic activation system.
<b>Conclusion Remarks</b>	No evidence of mutagenicity.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Muller W. (1993) Evaluation of mutagenicity testing with <i>Salmonella typhimurium</i> TA102 in three different laboratories. Environmental Health Perspectives Supplemnts. 101, 33-36.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	99.7% analyzed purity
<b>Method/guideline</b>	Ames test
<b>Test Type</b>	Ames reverse mutation
<b>System of Testing</b>	Bacterial

<b>GLP</b>	Ambiguous
<b>Year</b>	1983
<b>Species/Strain</b>	<i>Salmonella typhimurium</i> TA1535, TA 1537, TA98, TA100
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced Sprague Dawley rats
<b>Doses/concentration levels</b>	0.3-3333 micrograms/plate
<b>Statistical Methods</b>	Model used presented in Margolin <i>et al.</i> , 1981
<b>Remarks for Test Conditions</b>	At least five doses of the test chemical, in addition to solvent and positive controls, were tested on each strain in the presence of S9 mix or buffer. Three plates were used and the experiment was repeated no less than 1 week after completion of the initial test.
<b>Results</b>	Negative
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	Yes
<b>Remarks for results</b>	Limonene was inactive in <i>Salmonella</i> strains TA 1535, TA1537, TA98, and TA100 in the presence and absence of metabolic activation system.
<b>Conclusion Remarks</b>	No evidence of mutagenicity.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	Haworth, S., Lawlor T., Mortelmans K., Speck W., and Zeiger E. (1983) <i>Salmonella</i> Mutagenicity Test Results for 250 Chemicals. Environmental Mutagenesis Supplement 1, 3-142.

<b>Substance Name</b>	Orange peel oil, sweet ( <i>Citrus sinensis</i> (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	Ames test
<b>Test Type</b>	Ames reverse mutation
<b>System of Testing</b>	Bacterial
<b>GLP</b>	No
<b>Year</b>	1989
<b>Species/Strain</b>	<i>Salmonella typhimurium</i> TA 98, TA 100, TA 1535, TA 1537, and TA1538
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced rats

<b>Doses/Concentration</b>	5000 micrograms/plate
<b>Remarks for Test Conditions</b>	After two days incubation at 37 °C, revertant colonies were counted.
<b>Results</b>	No mutagenic effects.
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Orange oil was inactive in <i>Salmonella</i> strains TA 1535, TA 1537, TA 1538, TA 98 & TA 100 both in the presence and absence of metabolic activation system.
<b>Conclusion Remarks</b>	No evidence of mutagenicity.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Heck, J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989). An evaluation of food flavoring ingredients in a genetic toxicity screening battery The Toxicologist, 9(1), 257.

<b>Substance Name</b>	Orange peel oil, sweet ( <i>Citrus sinensis</i> (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	Ames test
<b>Test Type</b>	Ames reverse mutation
<b>System of Testing</b>	Bacterial
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain</b>	<i>Salmonella typhimurium</i> TA 98 and TA 100
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced rats
<b>Doses/Concentration</b>	100 microliters/plate
<b>Remarks for Test Conditions</b>	S-9 level used was 50 microliters/plate.
<b>Results</b>	No mutagenic effects.
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Orange oil was inactive in <i>Salmonella</i> strains TA 98 & TA 100 both in the presence and absence of metabolic activation

<b>Conclusion Remarks</b>	both in the presence and absence of metabolic activation system. No evidence of mutagenicity.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Crebelli R., Aquilina G., Conti L. and Carere A. (1990) Microbial mutagenicity screening of natural flavoring substances. Microbiologica 13, 115-119.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Mouse Lymphoma Forward Mutation Assay (MLY)
<b>Test Type</b>	Forward mutation
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain</b>	L5178Y Mouse Lymphoma cell line
<b>Metabolic Activation</b>	With and without rat liver microsome fraction S9 from Aroclor induced rats
<b>Doses/Concentration</b>	100 micrograms/ml
<b>Remarks for Test Conditions</b>	Cells were exposed for four hours, and then washed and incubated at 37 degrees for 48 hours before cloning. Colonies were counted after 10-14 days growth using an automatic colony counter.
<b>Results</b>	No mutagenic effects.
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Limonene was negative for mutagenic activity.
<b>Conclusion Remarks</b>	No evidence of mutagenicity.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Heck J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989). An evaluation of food flavoring ingredients in a genetic toxicity screening battery The Toxicologist, 9(1), 257.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	Mouse Lymphoma Forward Mutation Assay (MLY).
<b>Test Type</b>	Forward mutation
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1989
<b>Species/Strain</b>	L5178Y Mouse Lymphoma cell line
<b>Metabolic Activation</b>	With and without rat liver microsome fraction S9 from Aroclor induced rats
<b>Doses/Concentration</b>	0-100 micrograms/ml
<b>Remarks for Test Conditions</b>	Cells were exposed for four hours, and then washed and incubated at 37 °C for 48 hours before cloning. Colonies were counted after 9-12 days growth using an automatic colony counter.
<b>Results</b>	No mutagenic effects.
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Limonene was negative for mutagenic activity.
<b>Conclusion Remarks</b>	No evidence of mutagenicity.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Myhr B., McGregor D., Bowers L., Riach C., Brown A.G., Edwards I., McBride D., Martin R., and Caspary W.J. (1990) L5178Y Mouse Lymphoma Cell Mutation Assay Results With 41 Compounds. Environmental and Molecular Mutagenesis. 16, 138-167.

<b>Substance Name</b>	Orange peel oil, sweet (Citrus sinensis (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	Mouse Lymphoma Forward Mutation Assay (MLY)
<b>Test Type</b>	Forward mutation

<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain</b>	L5178Y Mouse Lymphoma cell line
<b>Metabolic Activation</b>	With and without rat liver microsome fraction S9 from Aroclor induced rats
<b>Doses/Concentration</b>	40-120 micrograms/ml, 125-200 micrograms/ml
<b>Remarks for Test Conditions</b>	Cells were exposed for four hours, and then washed and incubated at 37 degrees for 48 hours before cloning. Colonies were counted after 10-14 days growth using an automatic colony counter.
<b>Results</b>	Positive responses were observed with and without S-9, the latter only at highly toxic concentrations (relative survival less than 10%).
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	Positive
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Orange oil was positive with and without S-9.
<b>Conclusion Remarks</b>	The authors stated that the low pH associated with the material may have contributed to the positive outcome. The authors recommended additional assays to clarify the positive response in the MLY assay.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Heck J. D., Vollmuth, T. A., Cifone, M. A., Jagannath, D. R., Myhr B., and R.D. Curren (1989). An evaluation of food flavoring ingredients in a genetic toxicity screening battery The Toxicologist, 9(1), 257.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Sister Chromatid Exchange in Chinese hamster ovary cells (Galloway <i>et al.</i> , 1985) with minor modifications
<b>Test Type</b>	Sister Chromatid Exchange
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain</b>	Chinese hamster ovary cells

<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced Sprague Dawley rats
<b>Doses/Concentration</b>	16.2-162 micrograms/ml limonene
<b>Statistical Methods</b>	Trend test (Margolin <i>et al.</i> , 1986)
<b>Remarks for Test Conditions</b>	The standard protocol as published by Galloway <i>et al.</i> was employed with minor modifications. Limonene was tested with and without activation. S-9 was used at a concentration of 15 or 20 microliters per milliliters.
<b>Results</b>	Negative
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	Negative
<b>Appropriate statistical evaluations</b>	Yes
<b>Remarks for results</b>	Negative
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	Anderson B.E., Zeiger E., Shelby M.D., Resnick M.A., Gulati D.K., Ivett J.L., and Loveday K.S. (1990) Chromosome aberration and Sister Chromatid Exchange Test Results with 42 chemicals. Environmental and Molecular Mutagenesis 16, 55-137.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene
<b>Method/guideline</b>	In Vitro Sister Chromatid Exchange Test with Human Lymphocytes performed according to (Preston <i>et al.</i> , 1987)
<b>Test Type</b>	Sister Chromatid Exchange
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1991
<b>Species/Strain</b>	Human lymphocytes
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced Sprague Dawley rats
<b>Doses/Concentration</b>	Up to 1000 micrograms/ml
<b>Statistical Methods</b>	Not given
<b>Remarks for Test Conditions</b>	Peripheral blood samples were obtained from one male and one female non-smoker. The test substances were added after 48 hr either for a period of 24 hours (without S-9 mix) or for a

<b>Results</b>	period of 2 hours (with S-9 mix). Myrcene was dissolved in ethanol. The mitotic index was determined for 1000 cells and given as number of mitoses per 1000 cells. No increase in frequency of sister chromatid exchange with or without metabolic activation.
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Negative
<b>Conclusion Remarks</b>	The test substance was reported to have reduced the SCE inducing effect of S9 mix activated cyclophosphamide in human lymphocytes in a dose-dependent manner.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Kauderer B., Zamith H., Paumgarten J.R., and Speit G. (1991) Evaluation of the mutagenicity of <i>beta</i> -myrcene in mammalian cells in vitro. Environmental and Molecular Mutagenesis 18:28-34.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene
<b>Method/guideline</b>	In Vitro Sister Chromatid Exchange Test with Chinese Hamster Ovary V79 and HTC cells
<b>Test Type</b>	Sister Chromatid Exchange
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1991
<b>Species/Strain</b>	Chinese hamster ovary cells
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced Sprague Dawley rats
<b>Doses/Concentration</b>	Up to 500 micrograms/ml
<b>Statistical Methods</b>	Not given
<b>Remarks for Test Conditions</b>	V79 cells were exposed to myrcene for three hours in the presence or absence of S-9 mix. Hepatic tumour cell (HTC) line cells were cultivated for the duration of one cell cycle in bromodeoxyuridine containing medium and for another 20 hours in bromodeoxyuridine free medium. HTC cells were treated with the test substances during the first cell cycle (20 h).
<b>Results</b>	Negative



<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	Negative
<b>Appropriate statistical evaluations</b>	Not given
<b>Remarks for results</b>	Negative
<b>Conclusion Remarks</b>	The test substance was reported to have reduced the SCE inducing effect of S9 mix activated cyclophosphamide and aflatoxin B1 in V79 and HTC cells in a dose-dependent manner.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Roscheisen C., Zamith H., Paumgarten F., and Speit G. (1991) Influence of <i>beta</i> -myrcene on sister chromatid exchanges induced by mutagens in V79 and HTC cells. Mutation Research 264, 43-49.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Chromosome Aberration in Chinese hamster ovary cells (Galloway <i>et al.</i> , 1985) with minor modifications
<b>Test Type</b>	Chromosomal Aberration assay
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1990
<b>Species/Strain</b>	Chinese hamster ovary cells
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced Sprague Dawley rats
<b>Doses/Concentration</b>	50-500 micrograms/ml
<b>Statistical Methods</b>	Trend test (Margolin <i>et al.</i> , 1986)
<b>Remarks for Test Conditions</b>	The standard protocol as published by Galloway <i>et al.</i> was employed with minor modifications. Limonene was tested with and without activation. S-9 was used at a concentration of 15 or 20 microliters per milliliters.
<b>Results</b>	Negative
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	Negative
<b>Appropriate statistical evaluations</b>	Yes
<b>Remarks for results</b>	Negative

<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	Anderson B.E., Zeiger E., Shelby M.D., Resnick M.A., Gulati D.K., Ivett J.L., and Loveday K.S. (1990) Chromosome aberration and Sister Chromatid Exchange Test Results with 42 chemicals. Environmental and Molecular Mutagenesis 16, 55-137.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene
<b>Method/guideline</b>	<i>In Vitro</i> Chromosome Aberration Test with Human Lymphocytes performed according to (Preston <i>et al.</i> , 1987)
<b>Test Type</b>	Chromosomal Aberration assay
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1991
<b>Species/Strain</b>	Human lymphocytes
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced Sprague Dawley rats
<b>Doses/Concentration</b>	Up to 1000 micrograms/ml
<b>Statistical Methods</b>	Not given
<b>Remarks for Test Conditions</b>	Peripheral blood samples were obtained from one male and one female non-smoker. The test substances were added after 48 hr either for a period of 24 hours (without S-9 mix) or for a period of 2 hours (with S-9 mix). Myrcene was dissolved in ethanol. The mitotic index was determined for 1000 cells and given as number of mitoses per 1000 cells.
<b>Results</b>	No induction of chromosome aberrations with or without metabolic activation. No indication of cytotoxicity.
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Negative
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Kauderer B., Zamith H., Paumgarten J.R., and Speit G. (1991) Evaluation of the mutagenicity of <i>beta</i> -myrcene in mammalian cells in vitro. Environ. and Molecular Mutagenesis 18:28-34.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Cell Transformation in Syrian Hamster Embryo Cells
<b>Test Type</b>	Cell Transformation and Effect on Gap Junction Intercellular Communication
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	2000
<b>Species/Strain</b>	Syrian Hamster Embryo Cells
<b>Metabolic Activation</b>	None
<b>Doses/Concentration</b>	0.1-3 millimolar for Cell Transformation and 0.01-1 millimolar for Cellular Communication
<b>Statistical Methods</b>	One sided chi-square and ANOVA
<b>Remarks for Test Conditions</b>	Primary cell cultures from Syrian hamster embryos were prepared at 14 days gestation. The cells were exposed for 7 days starting 1 day after seeding of the target cells. Cells were observed for morphological transformation. Gap junction intercellular communication was measured as spreading of microinjected Lucifer Yellow dye to neighboring cells in a monolayer after 4 hours of exposure to test substances. The numbers of dye-coupled cells were counted 5-8 minutes following injection.
<b>Results</b>	Cell Transformation- 0.13% transformation frequency with a p-value of 0.089 using a chi-square.
<b>Cytotoxic concentration</b>	Cell Communication-No apparent effects Not given
<b>Genotoxic Effects</b>	Not applicable
<b>Appropriate statistical evaluations</b>	Yes
<b>Remarks for results</b>	Not statistically significant for cell transformation in Syrian Hamsters at the <i>alpha</i> = 0.05 level. No effect on cellular communication.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Rivedal E., Mikalsen S.O., and Sanner T. (2000) Morphological transformation and effect on gap junction intercellular communication in Syrian Hamster Embryo Cells as Screening Tests for Carcinogens Devoid of Mutagenic Activity.
<b>Substance Name</b>	<i>d</i> -Limonene

<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Cell Transformation in Syrian Hamster Embryo Cells
<b>Test Type</b>	Cell Transformation
<b>System of Testing</b>	Mammalian
<b>GLP</b>	No
<b>Year</b>	1980
<b>Species/Strain</b>	Syrian Hamster Embryo Cells
<b>Metabolic Activation</b>	None
<b>Doses/Concentration</b>	0.1-100 micrograms/ml
<b>Statistical Methods</b>	Not given
<b>Results</b>	Negative
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	Negative
<b>Appropriate statistical evaluations</b>	None
<b>Remarks for results</b>	Negative
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Pienta R.J. (1980) Evaluation and relevance of the syrian hamster embryo cell system. The Predictive Value of Short Term Screening Tests in Carcinogenicity Evaluation, 149-160.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene
<b>Method/guideline</b>	V79-HPRT Gene Mutation Test with CHO cells according to Li <i>et al.</i> , 1987
<b>Test Type</b>	Gene mutation
<b>System of Testing</b>	Mammalian
<b>GLP</b>	Ambiguous
<b>Year</b>	1991
<b>Species/Strain</b>	Chinese hamster ovary cells
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced Sprague Dawley rats

<b>Doses/Concentration</b>	Up to 1000 micrograms/ml
<b>Statistical Methods</b>	Not given
<b>Remarks for Test Conditions</b>	The cells were exposed to myrcene or the control substances for 3 hours in the presence or absence of S-9 mix.
<b>Results</b>	No increase in mutation frequencies at the hprt-locus in V79 cells. No indication of induced cytotoxicity.
<b>Cytotoxic concentration</b>	Non-toxic up to 1000 microrams/ml
<b>Genotoxic Effects</b>	None
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Negative
<b>Conclusion Remarks</b>	The test substance was reported to have toxic and mutagenic effect of cyclophosphamide in V79 cells.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Kauderer B., Zamith H., Paumgarten J.R., and Speit G. (1991) Evaluation of the mutagenicity of <i>beta</i> -myrcene in mammalian cells in vitro. Environmental and Molecular Mutagenesis 18:28-34.

<b>Substance Name</b>	Orange peel oil, sweet (Citrus sinensis (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	<i>Bacillus subtilis</i> recessive assay
<b>Test Type</b>	Reverse mutation test
<b>System of Testing</b>	Bacterial
<b>GLP</b>	Ambiguous
<b>Year</b>	1989
<b>Species/Strain</b>	<i>Bacillus subtilis</i>
<b>Metabolic Activation</b>	Rat liver microsome fraction S9 from Aroclor induced rats
<b>Doses/Concentration</b>	5-30 microliters/plate
<b>Results</b>	No mutagenic effects.
<b>Cytotoxic concentration</b>	Not given
<b>Genotoxic Effects</b>	Negative
<b>Appropriate statistical evaluations</b>	None given
<b>Remarks for results</b>	Orange oil was negative with or without S-9 activation.

<b>Data Qualities Reliabilities</b>	Reliability code 3. Not reliable.
<b>Remarks for Data Reliability</b>	Code 3. Documentation insufficient for assessment.
<b>References</b>	Kuroda K., Yoo S., Ishibashi T. (1989) Rec-assay of natural food additives. Seikatsu Eisei 33, 15-23.

#### 4.2.2 In vivo Genotoxicity

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Mammalian spot test
<b>GLP</b>	Ambiguous
<b>Year</b>	1984
<b>Species/Strain</b>	Mouse
<b>Sex</b>	Not reported
<b>Route of Administration</b>	Intraperitoneal
<b>Doses/Concentration</b>	215 mg/kg
<b>Exposure Period</b>	One day
<b>Remarks for Test Conditions</b>	Mouse embryos were treated in utero with limonene on days 10 and 11 post conception.
<b>Appropriate statistical evaluations?</b>	Yes, t-test
<b>Genotoxic effects</b>	No effects
<b>Remarks for Results</b>	No effects
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Fahrig R. (1984) Genetic mode of action of carcinogens and tumor promoters in yeast and mice. Molecular and General Genetics 194, 7-14.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene
<b>Method/guideline</b>	<i>in vivo</i> Cytogenetic Bone Marrow Assay

GLP	Ambiguous																																																									
Year	1993																																																									
Species/Strain	Rat/Wistar																																																									
Sex	Male and Female																																																									
Route of Administration	Oral-Gavage																																																									
Doses/Concentration	100, 500 or 1000 mg/kg																																																									
Exposure Period	24 and 48 hours																																																									
Remarks for Test Conditions	<i>beta</i> -Myrcene (100, 500 or 1000 mg/kg) was orally administered via gavage to two or four male and female Wistar rats. Corn oil was used as the negative control while cyclophosphamide (30 mg/kg via intraperitoneal injection) was used as the positive control. A mitotic inhibitor (colchicine 5 mg/kg ip) was injected 1 hr before sacrifice. At 24 or 48 hours, animals were sacrificed and bone marrow cells harvested. Evaluations included the mitotic index and the frequency of chromosomal aberrations.																																																									
Appropriate statistical evaluations?	Yes, Kruskal-Wallis test, Mann-Whitney test																																																									
Effect on mitotic index or PCE/NCE ratio by dose level and sex	<div>Corn oil (24 hr sampling)</div> <table><tr><th>Number</th><th>Sex</th><th>Mitotic index</th></tr><tr><td>2</td><td>Males</td><td>11.5</td></tr><tr><td>2</td><td>Females</td><td>12.5</td></tr><tr><td>4</td><td>Males and Females</td><td>12.0 +/- 2.9</td></tr></table> <div><i>beta</i>-Myrcene</div> <div>100 mg/kg bw (24 hr)</div> <table><tr><td>2</td><td>Males</td><td>14.0</td></tr><tr><td>2</td><td>Females</td><td>17.0</td></tr><tr><td>4</td><td>Males and Females</td><td>15.5 +/- 8.5</td></tr></table> <div>500 mg/kg bw (24 hr)</div> <table><tr><td>2</td><td>Males</td><td>19.5</td></tr><tr><td>2</td><td>Females</td><td>19</td></tr><tr><td>4</td><td>Males and Females</td><td>19.2 +/-1.7</td></tr></table> <div>1000 mg/kg (24 hr)</div> <table><tr><td>4</td><td>Males</td><td>21.0</td></tr><tr><td>4</td><td>Females</td><td>23.0</td></tr><tr><td>4</td><td>Males and Females</td><td>22.0 +/- 6.1</td></tr></table> <div>1000 mg/kg bw (48 hr)</div> <table><tr><td>2</td><td>Males</td><td>16.5</td></tr><tr><td>2</td><td>Females</td><td>12.0</td></tr><tr><td>4</td><td>Males and Females</td><td>14.2 +/-3.6</td></tr></table> <div>Cyclophosphamide (24 hr)</div> <div>30 mg/kg ip</div> <table><tr><td>2</td><td>Males</td><td>10.5</td></tr><tr><td>2</td><td>Females</td><td>8.5</td></tr><tr><td>4</td><td>Males and Females</td><td>9.5+/- 3.7</td></tr></table>	Number	Sex	Mitotic index	2	Males	11.5	2	Females	12.5	4	Males and Females	12.0 +/- 2.9	2	Males	14.0	2	Females	17.0	4	Males and Females	15.5 +/- 8.5	2	Males	19.5	2	Females	19	4	Males and Females	19.2 +/-1.7	4	Males	21.0	4	Females	23.0	4	Males and Females	22.0 +/- 6.1	2	Males	16.5	2	Females	12.0	4	Males and Females	14.2 +/-3.6	2	Males	10.5	2	Females	8.5	4	Males and Females	9.5+/- 3.7
Number	Sex	Mitotic index																																																								
2	Males	11.5																																																								
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2	Females	8.5																																																								
4	Males and Females	9.5+/- 3.7																																																								

<b>Genotoxic effects</b>	2 Females 4 Males and Females Dose related increase in mitotic index, no statistically significant increases in frequency of chromosomal aberrations
<b>Remarks for Results</b>	A dose-related increase in the mitotic index in bone marrow cells was reported for rats administered <i>beta</i> -myrcene. The authors commented that this be an interaction between <i>beta</i> -myrcene, which is known to induce CYP-P450 enzymes, and colchicine, which arrests cell division at metaphase. Myrcene may have increased the bioavailability of colchicine leading to the increase in mitotic index observed in the experiment. No significant increases in chromosomal aberrations were reported in the treated animals at either 24 or 48 hours.
<b>Conclusion Remarks</b>	The authors concluded that given the results, <i>beta</i> -myrcene was not clastogenic to the rat when orally administered at dose levels up to 1000 mg/kg bw.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Zamith H.P., Vidal M.N.P., Speit G. and Paumgarten F.J.R. (1993) Absence of genotoxic activity of <i>beta</i> -myrcene in the in vivo cytogenetic bone marrow assay. Brazilian J Med Biol Res 26, 93-98.

### 4.3 Repeat dose Toxicity

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	Greater than 99% pure
<b>Method/guideline</b>	National Toxicology Program. Toxicology and Carcinogenesis study NTP TR 347
<b>GLP</b>	Yes
<b>Year</b>	1990
<b>Species/strain</b>	B6C3F1 Mice
<b>Sex</b>	Male and Female
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	0, 413, 825, 1650, 3300, or 6600 mg/kg bw/d
<b>Exposure Period</b>	16 days
<b>Frequency of Treatment</b>	Daily (5 days/week)
<b>Control Group</b>	Yes



<b>Post Exposure</b>	4 days
<b>Remarks for Test Conditions</b>	Groups of five mice of each sex were administered 0, 413, 825, 1650, 3300, or 6600 mg/kg <i>d</i> -limonene in corn oil by gavage once per day for 12 days over a 16 day period. Animals were housed five per cage and fed ad libitum. The animals were observed twice per day and weighed once per week. Necropsies were performed on all animals.
<b>NOAEL (NOEL)</b>	1650 mg/kg bw/d
<b>LOAEL(LOEL)</b>	3300 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	See remarks for results.
<b>Statistical Evaluation</b>	Yes
<b>Remarks for Results</b>	All but one animal receiving 3300 or 6600 mg/kg bw/d limonene died within three days of study initiation. No treatment-related clinical signs were observed in mice receiving doses of 1650 mg/kg bw/d or lower.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	National Toxicology Program (NTP) (1990) Carcinogenicity and toxicology studies of <i>d</i> -limonene in F344/N Rats and B6C3F1 mice. NTP-TR-347. U.S. Dept of Health and Human Services. NIH Publication No. 90-2802.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	Greater than 99% pure
<b>Method/guideline</b>	National Toxicology Program. Toxicology and Carcinogenesis study NTP TR 347
<b>GLP</b>	Yes
<b>Year</b>	1990
<b>Species/strain</b>	F344/N Rats
<b>Sex</b>	Male and Female
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	0, 413, 825, 1650, 3300, or 6600 mg/kg bw/d
<b>Exposure Period</b>	16 days
<b>Frequency of Treatment</b>	Daily (5 days/week)
<b>Control Group</b>	Yes
<b>Post Exposure</b>	4 days

<b>Remarks for Test Conditions</b>	Groups of five rats of each sex were administered 0, 413, 825, 1650, 3300, or 6600 mg/kg <i>d</i> -limonene in corn oil by gavage once per day for 12 days over a 16 day period. Animals were housed five per cage and fed ad libitum. The animals were observed twice per day and weighed once per week. Necropsies were performed on all animals.
<b>NOAEL (NOEL)</b>	1650 mg/kg bw/d
<b>LOAEL(LOEL)</b>	3300 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	All but two females receiving 3300 or 6600 mg/kg bw/d limonene died within two days of study initiation. No treatment related clinical signs were observed in rats receiving doses of 1650 mg/kg bw/d or lower.
<b>Statistical Evaluation</b>	Yes
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	National Toxicology Program (NTP) (1990) Carcinogenicity and toxicology studies of <i>d</i> -limonene in F344/N Rats and B6C3F1 mice. NTP-TR-347. U.S. Dept of Health and Human Services. NIH Publication No. 90-2802.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	Greater than 99% pure
<b>Method/guideline</b>	National Toxicology Program. Toxicology and Carcinogenesis study NTP TR 347
<b>GLP</b>	Yes
<b>Year</b>	1990
<b>Species/strain</b>	F344/N Rats
<b>Sex</b>	Male and Female
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	0, 150, 300, 600, 1200, or 2400 mg/kg bw/d
<b>Exposure Period</b>	13 weeks
<b>Frequency of Treatment</b>	Daily (5 days/week)
<b>Control Group</b>	Yes
<b>Remarks for Test Conditions</b>	Groups of ten rats of each sex were administered 0, 150, 300, 600, 1200 or 2400 mg/kg bw/d <i>d</i> -limonene in corn oil by gavage once per day, five days a week for 13 weeks. Animals were housed five per cage and fed ad libitum. The animals were observed twice per day and weighed once per week. Necropsies were performed on all animals. Histological

	<p>examinations were performed on all vehicle control and high dose animals and all female rats in the 1200 mg/kg group. Tissues examined included adrenal glands, brain, colon, esophagus, eyes (if grossly abnormal), femur, sternebrae or vertebrae including marrow, gross lesions and tissue masses with regional lymph nodes, heart kidneys, liver, lungs and mainstem bronchi, mammary gland, mandibular or mesenteric lymph nodes, pancreas, parathyroids, pituitary gland, prostate/testes or ovaries/uterus, salivary glands, small intestine, spinal cord (if neurologic signs present), spleen, stomach, thymus, thyroid gland, trachea, and urinary bladder. Kidneys were examined in all male rats.</p>
<b>NOAEL (NOEL)</b>	300 mg/kg bw/d
<b>LOAEL(LOEL)</b>	600 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	See remarks for results.
<b>Statistical Evaluation</b>	Yes
<b>Remarks for Results</b>	<p>Ninety percent of female rats (9/10) and fifty percent of male rats (5/10) receiving 2400 mg/kg bw/d limonene died within the first week of the study. The final mean body weights of male rats receiving the three highest doses (600, 1200 or 2400 mg/kg bw/d) were reported to be 6%, 12%, or 23% lower than that of the controls, respectively. Rough hair coats, lethargy, and excessive lacrimation were observed for all animals at the two highest dose levels. Nephropathy was reported for all groups of male rats but a dose related increase in severity of the lesion was reported for the dosed groups. The nephropathy was characterized by degeneration of epithelium in the convoluted tubules, granular casts with tubular lumens, primarily in the outer stripe of the outer medulla, and regeneration of the tubular epithelium. Hyaline droplets were observed in the epithelium of the proximal convoluted tubules in all groups of male rats including vehicle controls. Upon further review to determine if there were differences in these findings between control and treated animals, the blinded slides revealed no definite differences in the accumulation of hyaline droplets.</p>
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	<p>National Toxicology Program (NTP) (1990) Carcinogenicity and toxicology studies of <i>d</i>-limonene in F344/N Rats and B6C3F1 mice. NTP-TR-347. U.S. Dept of Health and Human Services. NIH Publication No. 90-2802.</p>

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	Greater than 99% pure

<b>Method/guideline</b>	National Toxicology Program. Toxicology and Carcinogenesis study NTP TR 347
<b>GLP</b>	Yes
<b>Year</b>	1990
<b>Species/strain</b>	B6C3F1 Mice
<b>Sex</b>	Male and Female
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	0, 125, 250, 500, 1000 or 2000 mg/kg bw/d
<b>Exposure Period</b>	13 weeks
<b>Frequency of Treatment</b>	Daily (5 days/week)
<b>Control Group</b>	Yes
<b>Remarks for Test Conditions</b>	<p>Groups of ten mice of each sex were administered 0, 125, 250, 500, 1000 or 2000 mg/kg bw/d <i>d</i>-limonene in corn oil by gavage once per day, five days a week for 13 weeks. Animals were housed five per cage and fed ad libitum. The animals were observed twice per day and weighed once per week.</p> <p>Necropsies were performed on all animals. Histological examinations were performed on all vehicle control and high dose animals. Tissues examined included adrenal glands, brain, colon, esophagus, eyes (if grossly abnormal), femur or sternbrae or vertebrae including marrow, gallbladder, gross lesions and tissue masses with regional lymph nodes, heart kidneys, liver, lungs and mainstem bronchi, mammary gland, mandibular or mesenteric lymph nodes, pancreas, parathyroids, pituitary gland, prostate/testes or ovaries/uterus, salivary glands, small intestine, spinal cord (if neurological signs present), spleen, stomach, thymus, thyroid gland, trachea, and urinary bladder.</p>
<b>NOAEL (NOEL)</b>	500 mg/kg bw/d
<b>LOAEL(LOEL)</b>	1000 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	<p>One of 10 males and 2/10 females administered 2000 mg/kg bw/d limonene and 1/10 females administered 500 mg/kg bw/d limonene died before the end of the study. Several other animals also died as a result of gavage error. Mean body weights were 10% lower than control for male mice and 2% lower than control for female mice for the two highest dose levels. An alveolar cell adenoma was reported in the lung of one female at the highest dose level. Clinical signs of rough hair coats and decreased activity were reported for the two highest dose levels.</p>
<b>Statistical Evaluation</b>	Yes
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.

**References**

National Toxicology Program (NTP) (1990) Carcinogenicity and toxicology studies of *d*-limonene in F344/N Rats and B6C3F1 mice. NTP-TR-347. U.S. Dept of Health and Human Services. NIH Publication No. 90-2802.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	<i>d</i> -limonene; greater than 99% pure
<b>Method/guideline</b>	Subchronic nephrotoxicity study
<b>GLP</b>	Ambiguous
<b>Year</b>	1989
<b>Species/strain</b>	F344/N Rats
<b>Sex</b>	Male
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	0, 2, 5, 10, 30, or 75 mg/kg bw/d
<b>Exposure Period</b>	13 weeks
<b>Frequency of Treatment</b>	Daily (5 days/week)
<b>Control Group</b>	Yes
<b>Remarks for Test Conditions</b>	Groups of five week old male rats received 0, 2, 5, 10, 30 or 75 mg/kg bw/d <i>d</i> -limonene daily via oral gavage for 13 weeks (5 days a week). Rats from selected dose groups were necropsied throughout the study (days 8-29), with all remaining rats necropsied at the end of the study. Rats were observed daily for toxicity signs. Body weights were taken daily.
<b>NOAEL (NOEL)</b>	5 mg/kg bw/d
<b>LOAEL(LOEL)</b>	30 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	5 mg/kg bw/d no effects 10 mg/kg bw/d formation of hyaline droplets 30 mg/kg bw/d increased relative kidney weight, formation of hyaline droplets; 75 mg/kg bw/d increased relative kidney and liver weights; increased granular casts in outer medulla; formation of hyaline droplets.
<b>Statistical Evaluation</b>	Yes, linear regression analyses
<b>Remarks for Results</b>	Linear regression analyses indicated increased relative kidney and liver weights at the two highest dose levels. Histological examination revealed changes characterized by hyaline droplet formation, granular casts and multiple cortical changes, all of which was classified as chronic nephrosis. Exacerbation of hyaline droplet formation was reported at the earliest necropsy eight days after administration at the 10 mg/kg bw/d dose level.

<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Webb D.R., Ridder M., and Alden C.L. (1989) Acute and subchronic nephrotoxicity of <i>d</i> -limonene in Fischer 344 rats.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>GLP</b>	No
<b>Year</b>	1977
<b>Species/strain</b>	Rat/Sprague Dawley
<b>Sex</b>	Not reported
<b>Route of Administration</b>	Oral
<b>Doses/concentration Levels</b>	0, 277, 554, 1385, or 2770 mg/kg bw/d
<b>Exposure Period</b>	30 days
<b>Frequency of Treatment</b>	Daily
<b>Control Group</b>	Yes
<b>Remarks for Test Conditions</b>	The test substance was orally administered to Sprague-Dawley rats daily for 30 days at the following dose levels 0, 277, 554, 1385, or 2770 mg/kg bw in order to investigate the effect on the fine structure of the liver, kidney and blood cells.
<b>NOAEL (NOEL)</b>	1385 mg/kg bw/d
<b>LOAEL(LOEL)</b>	2770 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	No morphological changes of renal corpuscles and tubular cells were observed. Some alterations were detected in the glomerular epithelium from the kidneys of rats treated at the highest dose level.
<b>Statistical Evaluation</b>	Not given
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Kodama R., Tahara S., Sato K., Noda K., Ide H., Nishihara H. (1977b) Studies on <i>d</i> -limonene as a Gallstone Solubilizer Fine Structure of Liver, Kidneys and Blood Cells from Rats given <i>d</i> -limonene. Oyo Yakuri 13(6), 875.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5

<b>Remarks for Substance</b>	Greater than 99% pure
<b>Method/guideline</b>	National Toxicology Program. Toxicology and Carcinogenesis study NTP TR 347
<b>GLP</b>	Yes
<b>Year</b>	1990
<b>Species/strain</b>	F344/N Rats
<b>Sex</b>	Male and Female
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	Males: 0, 75 or 150 mg/kg bw/d; Females: 0, 300 or 600 mg/kg bw/d
<b>Exposure Period</b>	103 weeks
<b>Frequency of Treatment</b>	Daily (5 days/week)
<b>Control Group</b>	Yes
<b>Remarks for Test Conditions</b>	Groups of fifty male and fifty female rats each were administered 0, 75 or 150 mg/kg bw/d or 0, 300 or 600 mg/kg bw/d <i>d</i> -limonene, respectively, in corn oil by gavage once per day, five days a week for 103 weeks. Animals were housed five per cage and fed ad libitum. The animals were observed twice per day and weighed once per week for 12 weeks and once per month thereafter. Necropsies were performed on all animals. Histological examinations were performed on all animals dying during the study; all vehicle control; all low dose female rats and all high dose animals. Tissues examined included adrenal glands, brain, cecum, colon, costochondral junction, duodenum, epididymus/seminal vesicles/tunica vaginalis/scrotal sac/prostate/testes or ovaries/uterus, esophagus, eyes, femur or sternbrae or vertebrae including marrow, gross lesions and tissue masses with regional lymph nodes, heart, ileum, jejunum, kidneys, larynx and pharynx, liver, lungs and bronchi, mammary gland, mandibular or mesenteric lymph nodes, nasal cavity and turbinates, oral cavity, pancreas, parathyroids, pituitary gland, preputial or clitoral gland, rectum, salivary glands, sciatic nerve, skin, spinal cord, spleen, stomach, thigh muscle, thymus, thyroid gland, trachea, urinary bladder and Zymbal gland. Tissues examined in low dose male rat groups included adrenal glands, kidney, liver, spleen, and testis.
<b>NOAEL (NOEL)</b>	Undetermined (male); 300 mg/kg bw/d (female)
<b>LOAEL(LOEL)</b>	75 mg/kg bw/d (male); 600 mg/kg bw/d (female)
<b>Toxic Response/effects by Dose Level</b>	Male Rats Body weight-5% reduction in high dose group. Survival rate-29/50; 33/50;40/50. Non-neoplastic effects-mineralization 7/50; 43/50; 48/50; epithelial hyperplasia 0/50; 35/50; 43/50 of the renal papilla; renal tubular cell hyperplasia 0/50; 4/50; 7/50. Neoplastic effects-renal tubular cell adenomas 0/50; 4/50; 8/50 an adenocarcinomas 0/50; 4/50; 3/50.

	<p>Female Rats</p> <p>Body weight-5% reduction in high dose group.</p> <p>Survival rate-42/50; 40/50;26/50.</p> <p>No neoplastic or nonneoplastic effects.</p> <p>Yes</p>
<b>Statistical Evaluation</b>	
<b>Remarks for results</b>	<p>Mean body weights for male rats administered 150 mg/kg bw/d <i>d</i>-limonene were generally 4-7% lower than vehicle controls from week 2 to study termination. Mean body weights of high dose females were generally 4-7% lower than vehicle controls from week 28 to study termination. No treatment related clinical signs were reported for the duration of the study. Survival of the high dose male group was significantly greater than that of the vehicle alone after week 81. Survival of the high dose female group was significantly lower than that of the vehicle controls after week 39. In the kidneys of male rats, dose-related increases in the incidences of mineralization and epithelial hyperplasia. A dose-related increase in the severity of spontaneous nephropathy was reported in male rats administered limonene. Increased incidence of tubular cell hyperplasia and neoplasia was also reported in dosed male rats. Tubular cell adenoma incidence in high dose male rats and tubular cell adenoma or tubular cell carcinomas (combined) in dosed male rats were significantly greater than vehicle controls.</p>
<b>Conclusion Remarks</b>	<p>The authors determined that under the conditions of these 2-year gavage studies there was clear evidence of carcinogenic activity of <i>d</i>-limonene for male F344/N rats as shown by increased incidences in tubular cell hyperplasia, adenomas, and adeno-carcinomas of the kidney. There was no evidence of carcinogenic activity of <i>d</i>-limonene for female rats receiving 300 or 600 mg/kg bw/d.</p> <p>It has been demonstrated that renal lesions, which were observed in the NTP study, resulted from the accumulation of aggregates of <math>\alpha</math>-2m-globulin (a low molecular-weight protein synthesized in the liver) and limonene or its metabolites in the P2 segment of the renal proximal tubule. This phenomenon has only been observed in the male F344/N rat [Strasser, 1988; Borghoff <i>et al.</i>, 1990]. The gene that encodes <math>\alpha</math>-2m-globulin has been isolated and the sequence deduced [Untermann <i>et al.</i>, 1981]. These proteins are expressed in the liver under hormonal control [Roy and Neuhaus, 1967; Wang and Hodgetts, 1998]. <math>\alpha</math>-2m-Globulin belongs to the <math>\alpha</math>-2m-globulin super family of proteins that are characterized by a unique hydrophobic binding pocket. The lesions do not develop in the female F344/N rat or in humans [Bucher <i>et al.</i>, 1986]. Subsequent investigations have shown that the <math>\alpha</math>-2m-globulin nephropathy found in the F344/N male rat does not develop in mammals that do not express the hepatic form of <math>\alpha</math>-2m-globulin [Swenberg, 1989] such as other strains of rats [Dietrich and Swenberg, 1991], mice [Bucher <i>et al.</i>, 1986; Lehman-McKeeman, 1994] and dogs [Webb, 1990].</p>



Transgenic mice that express rat  $\alpha$ -2m-globulin were tested for their ability to form hyaline droplets and develop nephropathies similar to their adult male rat counterparts [Lehman-McKeeman and Caudill, 1994]. This study involved male F344 rats as positive control, transgenic C57BL/6J mice as experimental group and native C57BL/6 mice as negative controls. The animals at age 70-75 days were placed in metabolic cages and received 150 mg/kg bw per day *d*-limonene in corn oil by gavage for three days. Limonene was used to induce renal nephropathy in adult male rats, as it was shown to be a potent inducer in the NTP studies [EPA, 1991; NTP, 1990]. Twenty-four (24) hours after the last dose, the animals were sacrificed and the kidneys analyzed for evidence of nephropathy. Hyaline droplet formation was evaluated on a subjective scale, size and intensity (0-4) multiplied by tubular loading (0-3) for an overall scale of 0-12 with 12 being the most severe. In the absence of *d*-limonene, the control groups transgenic mice and rats showed a hyaline droplet score of 1 +/- 0 and 6 +/- 0.5, respectively. The test transgenic mice and rats showed a hyaline droplet score of 2.5 +/- 0.3 and 11 +/- 1.3, respectively upon dosing with *d*-limonene. The native mice developed no signs of hyaline droplet formation and tested negative for presence of  $\alpha$ -2m-globulin in their urine. The authors assert that based on the data presented " $\alpha$ -2m-globulin is the only protein that is involved in the etiology of hyaline droplet nephropathy".

An increase in the kidney-type- $\alpha$ -2m-globulin was seen in the urine of male Sprague-Dawley rats when these animals were administered greater than 30 mg/kg/day of *d*-limonene for 7 days by gavage. The increases in the urinary kidney-type- $\alpha$ -2m-globulin are dose-dependent and parallel-elevated accumulation in the kidney cells [Saito, 1996]

In another study, adult male Wistar rats were administered two groups of chemical compounds, including 138 mg/kg bw isophorone, potassium bromate, 2-propanol and a series of benzene and anthracene derivatives, to study induction of accumulation of  $\alpha$ -2m-globulin and structure-activity relationships. A monoclonal antibody against  $\alpha$ -2m-globulin was employed in a competitive ELISA procedure to determine its concentration in urine or tissue samples without purification. Plasma concentrations of  $\alpha$ -2m-globulin were not significantly increased by any of the test compounds at 1 mmol/kg bw. Kidney tissue concentrations were found to be 297-300% higher than controls. The hyaline droplet accumulating (HDA) potential was dependent on the test compound but there was no relationship between HAD activity and the structure or the pathway used to metabolize the test substance [Hildebrand, 1997]

While humans produce low molecular weight serum proteins, which are reabsorbed by the kidney, there is no evidence that  $\alpha$ -2m-globulin is produced [Olson, 1990]. Urine collected from adult male F344 rats and humans revealed no evidence indicative of  $\alpha$ -2m-globulin production in humans [Olson, 1990].

It is unknown whether any human serum proteins possess a binding site similar to that of  $\alpha$ -2m-globulin. Although this is a possibility, it appears remote, since female rats and mice do not show the renal changes noted in male rats exposed to limonene. It should be noted that there is a class of human proteins referred to as the  $\alpha$ -2m-globulin-related proteins. They appear to have no functional relationship to the adult male rat urine proteins. The human protein has a higher molecular weight, 25 kDa and is a component of a neutrophil gelatinase complex [Kjeldsen *et al.*, 2000 and Triebel *et al.*, 1992]. An extensive review of the current scientific literature and genome databases reveals no native protein or biological entity that acts as a nephropathy agent like mature male rat  $\alpha$ -2m-globulin. The accumulated evidence indicates that it is the unique anatomical, physiological, and biochemical properties of the male rat kidney, especially the proximal convoluted tubule, that allows *d*-limonene to interfere with renal processing of the strain-specific  $\alpha$ -2m-globulin. Therefore, this process is not predictive of human carcinogenicity. In a comprehensive review of  $\alpha$ -2m-globulin nephropathy and associated renal tubule tumors produced in the male F344/N rat exposed to limonene and other simple chemical substances (e.g. isophorone, decalin and methyl isobutyl ketone), it was concluded that the F344/N rat is not an appropriate model for assessing human renal carcinogenic risk [EPA, 1991]. After careful review, it has been concluded that the mechanisms leading to the renal carcinogenic findings in the F344/N male rat are largely known and strongly indicate that the nephropathy associated with *d*-limonene have no significance for human risk assessment [Burdock *et al.*, 1990].

**Data Qualities Reliabilities**

Reliability code 1. Reliable without restriction.

**Remarks for Data Reliability**

Code 1. Guideline study.

**References**

National Toxicology Program (NTP) (1990) Carcinogenicity and toxicology studies of *d*-limonene in F344/N Rats and B6C3F1 mice. NTP-TR-347. U.S. Dept of Health and Human Services. NIH Publication No. 90-2802.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	Greater than 99% pure
<b>Method/guideline</b>	National Toxicology Program. Toxicology and Carcinogenesis study NTP TR 347
<b>GLP</b>	Yes
<b>Year</b>	1990
<b>Species/strain</b>	B6C3F1 Mice
<b>Sex</b>	Male and Female

<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	Males: 0, 250 or 500 mg/kg bw/d; Females: 0, 500 or 1000 mg/kg bw/d
<b>Exposure Period</b>	103 weeks
<b>Frequency of Treatment</b>	Daily (5 days/week)
<b>Control Group</b>	Yes
<b>Remarks for Test Conditions</b>	Groups of fifty male and fifty female mice each were administered 0, 250, or 500 mg/kg bw/d or 0, 500 or 1000 mg/kg bw/d <i>d</i> -limonene, respectively, in corn oil by gavage once per day, five days a week for 103 weeks. Animals were housed five per cage and fed ad libitum. The animals were observed twice per day and weighed once per week for 12 weeks and once per month thereafter. Necropsies were performed on all animals. Histological examinations were performed on all animals dying during the study, all vehicle controls, and all high dose animals. Tissues examined included adrenal glands, brain, cecum, colon, costochondral junction, duodenum, epididymus/seminal vesicles/tunica vaginalis/scrotal sac/prostate/testes or ovaries/uterus, esophagus, eyes, femur or sternbrae or vertebrae including marrow, gallbladder, gross lesions and tissue masses with regional lymph nodes, heart, ileum, jejunum, kidneys, larynx and pharynx, liver, lungs and bronchi, mammary gland, mandibular or mesenteric lymph nodes, nasal cavity and turbinates, oral cavity, pancreas, parathyroids, pituitary gland, preputial or clitoral gland, rectum, salivary glands, sciatic nerve, skin, spinal cord, spleen, stomach, thigh muscle, thymus, thyroid gland, trachea, urinary bladder and Zymbal gland. Tissues examined in low dose groups include liver for female mice.
<b>NOAEL (NOEL)</b>	500 mg/kg bw/d
<b>LOAEL(LOEL)</b>	Undetermined for males; 1000 mg/kg bw/d for female
<b>Toxic Response/effects by Dose Level</b>	Male mice Body weight- No effect. Survival rate-24/50;44/50;39/50. Nonneoplastic effects-No effects. Neoplastic effects-No effects.  Female mice Body weight- 10% reduction in high dose group by study end. Survival rate-43/50;44/50;43/50. Nonneoplastic effects-No effects. Neoplastic effects-No effects.
<b>Statistical Evaluation</b>	Yes
<b>Remarks for Results</b>	Mean body weights for female mice administered 1000 mg/kg bw/d <i>d</i> -limonene were generally 5-15% lower than vehicle controls from week 28 to study termination. No treatment related clinical signs were reported for the duration of the study. Survival of the low dose male group was significantly lower than that of the vehicle controls by study termination.

<b>Conclusion Remarks</b>	The authors determined that under the conditions of these 2-year gavage studies there was no evidence of carcinogenic activity of <i>d</i> -limonene for male or female B6C3F1 mice at the dose levels tested.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	National Toxicology Program (NTP) (1990) Carcinogenicity and toxicology studies of <i>d</i> -limonene in F344/N Rats and B6C3F1 mice. NTP-TR-347. U.S. Dept of Health and Human Services. NIH Publication No. 90-2802.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>GLP</b>	Ambiguous
<b>Year</b>	1987
<b>Species/strain</b>	F344/N Rats
<b>Sex</b>	Male
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	0, 75, 150, or 300 mg/kg bw/d
<b>Exposure Period</b>	27 days
<b>Frequency of Treatment</b>	Daily (5 days/week)
<b>Control Group</b>	Yes, vehicle only
<b>Remarks for Test Conditions</b>	Groups of five young adult male F344/N rats each were administered <i>d</i> -limonene at dose levels of 0, 75, 150 or 300 mg/kg bw/d five days a week for 27 days. Observations included daily body weight, weekly food intake, liver and kidney weights and light microscopy and histology of liver and kidneys. Rats were examined for hyaline drop formation, granular cast formation and chronic nephrosis. Two-dimensional gel electrophoresis evaluation of protein profiles was conducted on samples of kidneys in the 150 mg/kg dose group killed on day 6.
<b>NOAEL (NOEL)</b>	Less than 75 mg/kg bw/d
<b>LOAEL(LOEL)</b>	75 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	Dose related increases in liver and kidney weights were reported for all dose levels. Renal effects were noted including protein profile changes, hyaline droplet formation, and accumulation of <i>alpha</i> -2-globulin was reported.
<b>Statistical Evaluation</b>	Yes
<b>Conclusion Remarks</b>	Chronic nephrosis was present in all kidneys of treated animals killed on day 27. The authors noted that unlike female rats or

<b>Data Qualities Reliabilities</b>	higher mammalian species, male rats have anatomical, physiological and biochemical peculiarities involving the proximal convoluted tubule. Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Basic data given: comparable to guidelines/standards.
<b>References</b>	Kanerva R.L., Ridder G.M. Lefever F.R. and Alden C.L. (1987) Comparison of short-term renal effects due to oral administration of decalin or <i>d</i> -limonene in young adult male Fischer rats. <i>Fd Chem Toxicol</i> 25, 345-353.

<b>Substance Name</b>	Orange peel oil, sweet ( <i>Citrus sinensis</i> (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	28-Day Oral Toxicity Study
<b>GLP</b>	Yes
<b>Year</b>	1990
<b>Species/strain</b>	Rat/Sprague Dawley
<b>Sex</b>	Male and Female
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	0, 240, 600 or 1500 mg/kg bw/d
<b>Exposure Period</b>	30 days
<b>Frequency of Treatment</b>	Daily
<b>Control Group</b>	Yes, vehicle only
<b>Remarks for Test Conditions</b>	Groups of ten rats of each sex were administered 0, 240, 600 or 1500 mg/kg bw/d sweet orange oil in 1% methyl cellulose by gavage daily for 30 days. Observations included survival, clinical observations, body weights, food consumption, clinical pathology, gross pathology, organ weights and histopathology.
<b>NOAEL (NOEL)</b>	Less than 240 mg/kg bw/d
<b>LOAEL(LOEL)</b>	240 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	1500 mg/kg bw/d, Males-
<b>Statistical Evaluation</b>	Yes
<b>Remarks for Results</b>	No treatment related effects were reported for survival, clinical observations, body weights or food consumption. Decreases in glucose related to treatment were reported in the mid-dose females and high dose males and females. Increases in serum albumin and total serum protein were observed in all treated females and the high dose males. Histopathology revealed treatment related lesions in the nonglandular stomach of the high dose males and females and in the kidney of all treated

<b>Conclusion Remarks</b>	male groups. Kidney weights were also increased in the treated male groups and in the high dose female group. Liver weight increases related to treatment were reported for the high-dose females and all dosed male groups. The authors concluded that the NOEL under conditions of this study was less than 240 mg/kg bw/d for both male and female rats. The authors noted that the kidney changes observed in the male rat at all dose levels were expected given the known interaction between limonene and <i>alpha</i> -2-microglobulin. Limonene is the principal constituent (greater than 90%) of orange oil.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	Serota D. (1990) 28-Day oral toxicity study in rats. Unpublished report to FEMA.

<b>Substance Name</b>	Orange peel oil, sweet (Citrus sinensis (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	Immunotoxicity-PFC assay- (Plaque Forming Cell) Assay to sheep red blood cells; Host Resistance Assay- Listeria monocytogenes
<b>GLP</b>	Yes
<b>Year</b>	1994
<b>Species/strain</b>	B6C3F1 mice
<b>Sex</b>	Female
<b>Route of Administration</b>	Oral-Gavage
<b>Doses/concentration Levels</b>	0, 625, 1250 or 2500 mg/kg bw
<b>Exposure Period</b>	5 days
<b>Frequency of Treatment</b>	Daily
<b>Control Group</b>	Yes
<b>Remarks for Test Conditions</b>	Orange oil was administered intragastrically to female B6C3F1 mice daily for 5 days at dose levels of 0, 625, 1250 or 2500 mg/kg bw to determine effects on humoral and cell-mediated immune responses. A host resistance assay (Listeria monocytogenes bacterial challenge) was used to assess cell-mediated immunity while the antibody plaque forming cell response to sheep erythrocytes was used to measure humoral immunity. Other parameters evaluated included body weights, lymphoid organ weights and spleen cellularity but in the absence of modulation of the PFC response, these effects were not considered indicators of immunotoxicity.
<b>NOAEL (NOEL)</b>	2500 mg/kg bw/d

<b>LOAEL(LOEL)</b>	Greater than 2500 mg/kg bw/d
<b>Toxic Response/effects by Dose Level</b>	None
<b>Statistical Evaluation</b>	Yes
<b>Conclusion Remarks</b>	Orange oil had no effects on cell-mediated or humoral immune response at any dose level tested.
<b>Data Qualities Reliabilities</b>	Reliability code 1. Reliable without restriction.
<b>Remarks for Data Reliability</b>	Code 1. Guideline study.
<b>References</b>	Gaworski, C. L., Vollmuth, T. A., Dosier, M. M., Heck, J. D., Dunn, L. T., Ratajczak, H. V. and Thomas, P. T. (1994). An Immunotoxicity Assessment of Food Flavouring Ingredients. Food Chem. Toxicol. 32(5): 409-415.

#### 4.4 Reproductive Toxicity

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene
<b>Method/guideline</b>	Not given
<b>GLP</b>	Ambiguous
<b>Year</b>	1993
<b>Species/Strain</b>	Rat/Wistar
<b>Sex</b>	Female
<b>Route of Administration</b>	Oral
<b>Duration of Test</b>	Approximately 128 days
<b>Doses/Concentration</b>	250, 500, 1000 or 1500 mg/kg bw/d
<b>Premating Exposure period for males</b>	Not applicable
<b>Premating Exposure period for females</b>	27, 28 or 29 days depending upon delivery date
<b>Control Group and Treatment</b>	Yes, vehicle only (corn oil at 2.5 ml/kg bw)
<b>Frequency of Treatment</b>	Daily
<b>Remarks for Test Conditions</b>	<i>beta</i> -Myrcene was administered to female Wistar rats via gavage at dose levels of 0, 250, 500, 1000 or 1500 mg/kg bw/d from the 15th day of gestation until weaning of the offspring which was day 21 postnatal. The vehicle was corn oil. Mortality, weight gain and postnatal development were

<b>NOAEL(NOEL)</b>	evaluated. Reproductive capacity was assessed in the exposed offspring upon reaching maturity (120 days). 250 mg/kg bw/d
<b>LOAEL(LOEL)</b>	500 mg/kg bw/d
<b>Appropriate statistical evaluations</b>	One way ANOVA and student t test
<b>Remarks for Results</b>	No adverse effects were noted in the offspring at the lowest dose level tested. Decreased body weight, increased perinatal mortality, and delayed developmental landmarks were noted at the 500, 1000 and 1500 mg/kg bw/d dose levels. Fertility was impaired in female offspring exposed to the two highest doses of <i>beta</i> -myrcene.
<b>Data Reliabilities Qualities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Comparable to guideline study with acceptable restrictions.
<b>References</b>	Delgado I.F., Nogueira A. C., Souza C.M., Costa M.N., Figueiredo L.H., Mattos A.P., Chahoud I. And Paumgarten F. (1993b) Peri- and postnatal developmental toxicity of <i>beta</i> -myrcene in the rat. <i>Fd Chem Toxic</i> 31, 623-628.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene
<b>Method/guideline</b>	Not given
<b>GLP</b>	Ambiguous
<b>Year</b>	1998
<b>Species/Strain</b>	Rat/Wistar
<b>Sex</b>	Male and Female
<b>Route of Administration</b>	Oral-Gavage
<b>Duration of Test</b>	Approximately 86 days for female animals; approximately 112 days for male animals
<b>Doses/Concentration</b>	100,300, or 500 mg/kg bw/d
<b>Premating Exposure period for males</b>	91 days
<b>Premating Exposure period for females</b>	21 days
<b>Control Group and Treatment</b>	Yes, vehicle only (peanut oil at 2.5 ml/kg bw)
<b>Frequency of Treatment</b>	Daily
<b>Remarks for Test Conditions</b>	Three experimental groups (15 male and 45 female Wistar rats per group) were administered <i>beta</i> -myrcene dissolved in peanut oil via gavage at dose levels of 0, 100, 300, or 500 mg/kg bw/d. The exposure period was 91 days prior to and



	<p>during mating the mating period for the males and 21 days prior to and during the mating period for females, pregnancy, and lactation until 21 days post parturition. All parent animals were evaluated for weight development, mortality, and toxicity signs. Pregnant females were also evaluated for weight gain, spontaneous abortions, dystocia and prolonged duration of pregnancy. All males were sacrificed and decapitated at the conclusion of mating. One third of the females in each dose group were sacrificed at day 21 of pregnancy. The gravid uterus weight was recorded; resorption and living and dead fetuses were counted. Implantation sites were counted. All fetuses were examined for skeletal abnormalities. After the remaining pregnant females gave birth, the offspring was weighed, and examined for signs of developmental delays, specifically, incisor eruption, fur development, downy hair development, and eye opening. At weaning on day 21, all mothers were sacrificed and necropsied.</p>
<b>NOAEL(NOEL)</b>	300 mg/kg bw/d
<b>LOAEL(LOEL)</b>	500 mg/kg bw/d
<b>Appropriate statistical evaluations</b>	Yes, one way ANOVA, two tailed student t test
<b>Parental data and F1 as Appropriate</b>	<p>No deaths or signs of toxicity were reported in male rats at any dose level. No statistically significant differences in body weight gain were reported between control and test animals. A slight increase in liver and kidney weights was reported for treated male (highest dose only) and female rats. No morphological alterations of the liver or testis tissue were revealed upon examination. No effects were reported on the number of spermatids in the testis or on the number of spermatozoa in the cauda epididymis. No adverse effects on body weight gain and no other signs of toxicity were observed in treated female rats during the premating or mating periods. No treatment related effects were reported on fertility as measured by the mating index and pregnancy index upon comparison to controls. At the highest dose level, a slight increase in the resorption rate and a parallel decrease in the ratio of live fetuses per implantation site were reported.</p>
<b>Offspring toxicity F1 and F2</b>	<p>Increases in the occurrence of fetal skeleton abnormalities between control and treated groups were reported at the 500 mg/kg bw/d level. No adverse effects were reported on duration of pregnancy, labor, pup mortality, and maternal or offspring weight changes. Slight delays in incisor eruption (300 mg/kg bw/d) and eye opening (100, 300 mg/kg bw/d) were reported but were not dose-related.</p>
<b>Remarks for Results</b>	<p>The authors attributed the increase in skeletal abnormalities at the highest dose level tested to known strain-specific anomalies including increases in dislocated sternums, and lumbar extra ribs.</p>
<b>Conclusion Remarks</b>	<p>The authors concluded that the NOAEL for toxic effects on fertility and general reproductive performance via the oral route was 300 mg <i>beta</i>-myrcene/kg bw/d.</p>
<b>Data Reliabilities Qualities</b>	Reliability code 2. Reliable with restriction.

<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Paumgarten F.J., De-Carvalho R.R., Souza C.C., Madi K. and Chahoud I. (1998) Study of the effects of <i>beta</i> -Myrcene on rat fertility and general reproductive performance. Braz J Med Biol Res, 31(7).

<b>Substance Name</b>	Orange peel oil, sweet (Citrus sinensis (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	<i>in vivo</i> Reproductive and Developmental Toxicity Screening Test
<b>GLP</b>	Yes
<b>Year</b>	1989
<b>Species/Strain</b>	Rat/Sprague Dawley
<b>Sex</b>	Female
<b>Route of Administration</b>	Oral-Gavage
<b>Duration of Test</b>	39 days
<b>Doses/Concentration</b>	0, 375, 750 or 1500 mg/kg bw/d
<b>Premating Exposure period for males</b>	Not applicable
<b>Premating Exposure period for females</b>	7 days
<b>Control Group and Treatment</b>	Yes, vehicle only (corn oil)
<b>Frequency of Treatment</b>	Daily
<b>Remarks for Test Conditions</b>	Groups of ten female rats were orally administered sweet orange oil via gavage at dose levels of 0, 375, 750 or 1500 mg/kg bw/d for seven days prior to and through cohabitation, gestation, delivery and a four day lactation period. The vehicle was corn oil. Body weights, food consumption and clinical signs were recorded throughout the observation period. All dams were necropsied and examined for gross lesions on day 25 of presumed gestation for rats not delivering a litter and four days postpartum for rats delivering a litter. Pups delivered were sacrificed on day 4 post partum, any pups dying during the lactation period were necropsied.
<b>NOAEL(NOEL)</b>	Less than 375 mg/kg bw/d
<b>LOAEL(LOEL)</b>	375 mg/kg bw/d
<b>Appropriate statistical evaluations</b>	Yes
<b>Parental data and F1 as Appropriate</b>	No deaths occurred at any dose level. Statistically significant numbers of rats from all three dose groups experienced excess salvation during the pre-mating and gestation periods, and during the lactation period for high-dose animals. The dosed

<b>Offspring toxicity F1 and F2</b>	rats had decreased weight gains compared to the control rats during the seven day premating period. Absolute and relative maternal food consumption was significantly decreased for the 750 and 1500 mg/kg bw/d dose groups during the seven day premating period. No treatment related effect on mating performance or fertility was reported at any dose level.
<b>Conclusion Remarks</b>	A significant increase in stillbirths and pup deaths was reported for the highest dose group compared to the control group. The treatment with sweet orange oil had no effect on the incidence of malformations or gross lesions in the pups.
<b>Data Reliabilities Qualities</b>	The NOAEL for administration of sweet orange peel oil under the conditions of this study was reported to be less than 375 mg/kg bw/d for maternal toxicity and 750 mg/kg bw/d for offspring development.
<b>Remarks for Data Reliability</b>	Reliability code 2. Reliable with restriction.
<b>References</b>	Code 2. Comparable to guideline study with acceptable restrictions.
	Hoberman A.M., Vollmuth T.A., Bennett M.B. and M.S. Christian (1989) An evaluation of food flavoring ingredients using an in vivo reproductive and developmental toxicity screening test. Private communication.

#### 4.5 Developmental/Teratogenicity Toxicity

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Not given
<b>GLP</b>	Ambiguous
<b>Year</b>	1975
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Female
<b>Route of Administration</b>	Oral
<b>Duration of Test</b>	7 days
<b>Doses/concentration Levels</b>	0, 591 or 2869 mg/kg bw/d
<b>Exposure Period</b>	Daily from day 9 to 15 of gestation
<b>Frequency of Treatment</b>	Daily
<b>Control Group and Treatment</b>	Yes
<b>Remarks for Test Conditions</b>	Four groups of twenty Wistar female rats each were administered 0, 591 or 2869 mg/kg bw/d <i>d</i> -limonene on days 9-15 of gestation.

<b>NOAEL(NOEL) maternal toxicity</b>	591 mg/kg bw/d
<b>LOAEL(LOEL) maternal toxicity</b>	2869 mg/kg bw/d
<b>NOAEL (NOEL) developmental toxicity</b>	591 mg/kg bw/d
<b>LOAEL (LOEL) developmental toxicity</b>	2869 mg/kg bw/d
<b>Actual dose received by dose level and sex</b>	Not given
<b>Maternal data with dose level</b>	2869 mg/kg bw/d- maternal body weight decreased, and increased mortality was reported
<b>Fetal Data with Dose Level</b>	2869 mg/kg bw/d-delayed ossification of fetuses metacarpal bone and proximal phalanx; decreased body weights; decreased weights of thymus, spleen, and ovaries.
<b>Appropriate statistical evaluations</b>	Not given
<b>Remarks for Results</b>	At the highest dose level, increases in maternal mortality and decreases in maternal and fetal body weights were reported. Additionally at the highest dose level, delayed ossification of fetal metacarpal bones and proximal phalanx and decreased weights of the thymus, spleen, and ovaries were reported.
<b>Conclusion Remarks</b>	The NOAEL for both maternal and offspring toxicity was reported to be 591 mg/kg bw/d.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Tsuji M., Y.Fujisaki, Y.Arikawa, S.Masuda, S.Kinoshita, A.Okubo, K.Noda, H.Ide and Y.Iwanaga (1975b) Studies on <i>d</i> -limonene as a gallstone solubilizer: Effects on Development of Rat Fetuses and Offsprings. Journal Oyo Yakuri, 10(2), 179.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Remarks for Substance</b>	<i>d</i> -Limonene
<b>Method/guideline</b>	Not given
<b>GLP</b>	Ambiguous
<b>Year</b>	1977
<b>Species/strain</b>	Rabbits/Japanese White
<b>Sex</b>	Female
<b>Route of Administration</b>	Oral
<b>Duration of Test</b>	13 days
<b>Doses/concentration Levels</b>	0, 250, 500 or 1000 mg/kg bw/d

<b>Exposure Period</b>	Daily from day 6 to 18 of gestation
<b>Frequency of Treatment</b>	Daily
<b>Control Group and Treatment</b>	Yes
<b>Remarks for Test Conditions</b>	Pregnant Japanese white rabbits were administered 0, 250, 500 or 1000 mg/kg bw/d <i>d</i> -limonene on days 6 to 18 of gestation.
<b>NOAEL(NOEL) maternal toxicity</b>	250 mg/kg bw/d
<b>LOAEL(LOEL) maternal toxicity</b>	500 mg/kg bw/d
<b>NOAEL (NOEL) developmental toxicity</b>	Greater than 1000 mg/kg bw/d
<b>LOAEL (LOEL) developmental toxicity</b>	Not determined
<b>Actual dose received by dose level and sex</b>	Not given
<b>Maternal data with dose level</b>	1000 mg/kg bw/d-increased mortality; 500 and 1000 mg/kg bw/d-significant decreases in body weight gain and food consumption temporarily observed
<b>Fetal Data with Dose Level</b>	No treatment related effects reported.
<b>Appropriate statistical evaluations</b>	Not given
<b>Remarks for Results</b>	Increased maternal mortality was reported at the highest dose level. Significant decreases in maternal body weight gain and food consumption were temporarily observed at the 500 and 1000 mg/kg bw/d dose levels. No treatment related effects were reported for the offspring.
<b>Conclusion Remarks</b>	The NOAEL for maternal toxicity was 250 mg/kg bw/d. The NOAEL for offspring toxicity was greater than 1000 mg/kg bw/d.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Comparable to guideline study with acceptable restrictions.
<b>References</b>	Kodama R., Okubo A., Sato K., Araki E., Noda K., Ide H., and Ikeda T. (1977a) Studies on <i>d</i> -limonene as a gallstone solubilizer: Effect on development of rabbit fetuses and offsprings. <i>Journal Oyo Yakuri</i> , 13(6), 885-898.

<b>Substance Name</b>	<i>d</i> -Limonene
<b>CAS No.</b>	5989-27-5
<b>Method/guideline</b>	Not given
<b>GLP</b>	Ambiguous
<b>Year</b>	1977
<b>Species/strain</b>	Mice/ICR
<b>Sex</b>	Female

<b>Route of Administration</b>	Oral
<b>Duration of Test</b>	6 days
<b>Doses/concentration Levels</b>	0, 591 or 2363 mg/kg bw/d
<b>Exposure Period</b>	Daily from day 7 to 12 of gestation
<b>Frequency of Treatment</b>	Daily
<b>Control Group and Treatment</b>	Yes
<b>Remarks for Test Conditions</b>	Pregnant ICR mice were administered 0, 591 or 2363 mg/kg bw/d <i>d</i> -limonene on days 7 to 12 of gestation.
<b>NOAEL(NOEL) maternal toxicity</b>	591 mg/kg bw/d
<b>LOAEL(LOEL) maternal toxicity</b>	2363 mg/kg bw/d
<b>NOAEL (NOEL) developmental toxicity</b>	591 mg/kg bw/d
<b>LOAEL (LOEL) developmental toxicity</b>	2363 mg/kg bw/d
<b>Actual dose received by dose level and sex</b>	Not given
<b>Maternal data with dose level</b>	2363 mg/kg bw/ <i>d</i> -significant decrease of body weight gain
<b>Fetal Data with Dose Level</b>	2363 mg/kg bw/ <i>d</i> -increased incidence of fused ribs compared to control; delayed ossification of some bones, which returned to normal after birth; significant decrease in body weight gain of male offspring
<b>Appropriate statistical evaluations</b>	Not given
<b>Remarks for Results</b>	Significant decreases in body weight gain were reported for pregnant ICR mice administered the highest dose level of <i>d</i> -limonene. In the offspring, increased incidence of fused ribs compared to that of the controls, delayed ossification of some bones and decreased body weight gain were reported at the highest dose level tested.
<b>Conclusion Remarks</b>	The NOAEL for both maternal and offspring toxicity was reported to be 591 mg/kg bw/d.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Comparable to guideline study with acceptable restrictions.
<b>References</b>	Kodama R., Okubo A., Sato K., Araki E., Noda K., Ide H., and Ikeda T. (1977a) Studies on <i>d</i> -limonene as a gallstone solubilizer: Effect on development of mouse fetuses and offsprings. <i>Journal Oyo Yakuri</i> , 13(6), 885-898.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene

<b>Method/guideline</b>	Not given
<b>GLP</b>	Ambiguous
<b>Year</b>	1993
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Female
<b>Route of Administration</b>	Oral
<b>Duration of Test</b>	10 days
<b>Doses/concentration Levels</b>	0, 250, 500 or 1200 mg/kg bw/d
<b>Exposure Period</b>	Daily from day 6 to 15 of gestation
<b>Frequency of Treatment</b>	Daily
<b>Control Group and Treatment</b>	Yes
<b>Remarks for Test Conditions</b>	Pregnant Wistar rats were administered 0, 250, 500 or 1200 mg/kg bw/d <i>beta</i> -myrcene on gestational days 6-15. The vehicle was corn oil.
<b>NOAEL(NOEL) maternal toxicity</b>	500 mg/kg bw/d
<b>LOAEL(LOEL) maternal toxicity</b>	1200 mg/kg bw/d
<b>NOAEL (NOEL) developmental toxicity</b>	500 mg/kg bw/d
<b>LOAEL (LOEL) developmental toxicity</b>	1200 mg/kg bw/d
<b>Actual dose received by dose level and sex</b>	Not given
<b>Maternal data with dose level</b>	1200 mg/kg bw/d-1/29 maternal deaths. Decreased maternal weight gain.
<b>Fetal Data with Dose Level</b>	1200 mg/kg bw/d-Increased skeletal malformations.
<b>Appropriate statistical evaluations</b>	Yes
<b>Remarks for Results</b>	Decreased maternal weight gain was reported at the 1200 mg/kg bw/d dose. Increased fetal skeletal malformations were reported at the 1200 mg/kg bw/d dose level.
<b>Conclusion Remarks</b>	The NOAEL for both maternal and offspring toxicity was reported to be 500 mg/kg bw/d.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Delgado I.F., Carvalho R.R., Nogueira A., Mattos A.P., Figueiredo L.H., Oliveira S.H.P., Chahoud I., and Paumgarten F.J.R. (1993a) Study on embryo-fetotoxicity of <i>beta</i> -myrcene in the rat. Food Chem Toxic 31, 31-35.

<b>Substance Name</b>	Myrcene
<b>CAS No.</b>	123-35-3
<b>Remarks for Substance</b>	<i>beta</i> -Myrcene
<b>Method/guideline</b>	Not given
<b>GLP</b>	Ambiguous
<b>Year</b>	1993
<b>Species/strain</b>	Rat/Wistar
<b>Sex</b>	Female
<b>Route of Administration</b>	Oral
<b>Duration of Test</b>	Approximately 128 days
<b>Doses/concentration Levels</b>	0, 250, 500, 1000 or 1500 mg/kg bw/d
<b>Exposure Period</b>	27, 28 or 29 days depending upon delivery date
<b>Frequency of Treatment</b>	Daily
<b>Control Group and Treatment</b>	Yes, vehicle only (corn oil at 2.5 ml/kg bw)
<b>Remarks for Test Conditions</b>	<i>beta</i> -Myrcene was administered via gavage to female Wistar rats from pregnancy day 15 until weaning of the offspring which was day 21 postnatal. The vehicle was corn oil. Mortality, weight gain and postnatal development were evaluated. Reproductive capacity was assessed in the exposed offspring upon reaching maturity (120 days).
<b>NOAEL(NOEL) maternal toxicity</b>	500 mg/kg bw/d
<b>LOAEL(LOEL) maternal toxicity</b>	1000 mg/kg bw/d
<b>NOAEL (NOEL) developmental toxicity</b>	250 mg/kg bw/d
<b>LOAEL (LOEL) developmental toxicity</b>	500 mg/kg bw/d
<b>Actual dose received by dose level and sex</b>	Not given
<b>Maternal data with dose level</b>	1500 mg/kg bw/d: 5/15 deaths within first four days of treatment; decreased weight. 1000 mg/kg bw/d: No maternal deaths. Weight deficit observed at term no longer present at parturition.
<b>Fetal Data with Dose Level</b>	500, 1000, or 1500 mg/kg bw/d: decreased body weight, increased perinatal mortality and delayed developmental landmarks; impaired fertility (1000 and 1500 mg/kg bw/d only)
<b>Appropriate statistical evaluations</b>	One way ANOVA and student t test
<b>Remarks for Results</b>	No adverse effects were noted in the offspring at the lowest dose level tested. Decreased body weight, increased perinatal mortality, and delayed developmental landmarks were noted at the 500, 1000 and 1500 mg/kg bw/d dose levels. Fertility was



<b>Conclusion Remarks</b>	impaired in female offspring exposed to the two highest doses of <i>beta</i> -myrcene. The NOAEL for peri- and post natal development was set at 250 mg/kg bw/d.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Comparable to guideline study with acceptable restrictions.
<b>References</b>	Delgado I.F., Nogueira A. C., Souza C.M., Costa M.N., Figueiredo L.H., Mattos A.P., Chahoud I. And Paumgarten F. (1993b) Peri- and postnatal developmental toxicity of <i>beta</i> -myrcene in the rat. <i>Fd Chem Toxic</i> 31, 623-628.

<b>Substance Name</b>	Orange peel oil, sweet ( <i>Citrus sinensis</i> (L.) Osbeck)
<b>CAS No.</b>	8008-57-9
<b>Method/guideline</b>	<i>in vivo</i> Reproductive and Developmental Toxicity Screening Test
<b>GLP</b>	Yes
<b>Year</b>	1989
<b>Species/strain</b>	Rat/Sprague Dawley
<b>Sex</b>	Female
<b>Route of Administration</b>	Oral-Gavage
<b>Duration of Test</b>	39 days
<b>Doses/concentration Levels</b>	0, 375, 750 or 1500 mg/kg bw/d
<b>Exposure Period</b>	38 days
<b>Frequency of Treatment</b>	Daily
<b>Control Group and Treatment</b>	Yes, vehicle only (corn oil)
<b>Remarks for Test Conditions</b>	Groups of ten female rats were orally administered sweet orange oil via gavage at dose levels of 0, 375, 750 or 1500, 375 mg/kg bw/d for seven days prior to and through cohabitation, gestation, delivery and a four day lactation period. The vehicle was corn oil. Body weights, food consumption and clinical signs were recorded throughout the observation period. All dams were necropsied and examined for gross lesions on Day 25 of presumed gestation for rats not delivering a litter and four days postpartum for rats delivering a litter. Pups delivered were sacrificed on day 4 post partum, any pups dying during the lactation period were necropsied.
<b>NOAEL(NOEL) maternal toxicity</b>	Less than 375 mg/kg bw/d
<b>LOAEL(LOEL) maternal toxicity</b>	375 mg/kg bw/d
<b>NOAEL (NOEL) developmental toxicity</b>	750 mg/kg bw/d

<b>LOAEL (LOEL)</b>	1500 mg/kg bw/d
<b>developmental toxicity</b>	
<b>Maternal data with dose level</b>	No deaths occurred at any dose level. Statistically significant numbers of rats from all three dose groups experienced excess salivation during the pre-mating and gestation periods, and during the lactation period for high dose animals. The dosed rats had decreased weight gains compared to the control rats during the seven-day pre-mating period. Absolute and relative maternal food consumption was significantly decreased for the 750 and 1500 mg/kg bw/d dose groups during the seven day pre-mating period. No treatment related effects were reported on maternal body weight, changes in body weight, and absolute and relative feed consumption during the lactation period.
<b>Fetal Data with Dose Level</b>	A significant increase in stillbirths and pup deaths was reported for the highest dose group compared to the control group. The treatment with sweet orange oil had no effect on the incidence of malformations or gross lesions in the pups.
<b>Appropriate statistical evaluations</b>	Yes
<b>Conclusion Remarks</b>	The NOAEL for administration of sweet orange peel oil under the conditions of this study was reported to be less than 375 mg/kg bw/d for maternal toxicity and 750 mg/kg bw/d for offspring development.
<b>Data Qualities Reliabilities</b>	Reliability code 2. Reliable with restriction.
<b>Remarks for Data Reliability</b>	Code 2. Acceptable, well-documented publication/study report, which meets basic scientific principles.
<b>References</b>	Hoberman A.M., Vollmuth T.A., Bennett M.B. and M.S. Christian (1989) An evaluation of food flavoring ingredients using an in vivo reproductive and developmental toxicity screening test. Private communication.